Per ( Sec . 15)



## SCIENCE

15 May 1959

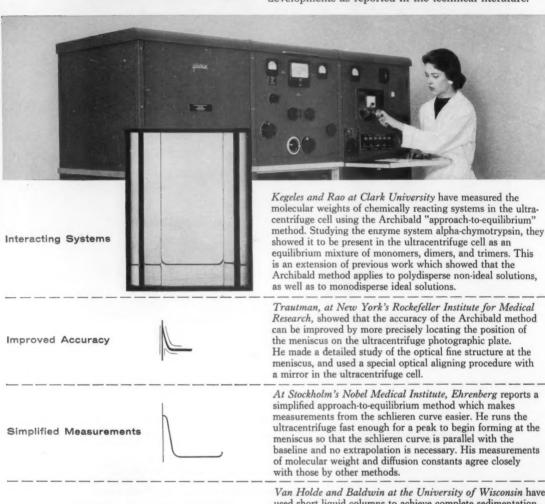
Volume 129, Number 3359



Copy	A. P. Carrier and	
Editorial	Science Writing Awards	1327
Articles	Push to the Desert: H. F. Gregor	1329
Ariicies	The pressure of agriculture on California's arid land illustrates the law of diminishing returns.	1329
	Chemistry of Insulin: F. Sanger	1340
	Determination of the structure of insulin opens the way to greater understanding of life processes.	
	Elmer Martin Nelson, Government Scientist: C. D. Tolle	1344
News of Science	Conservation Bill Faces Test in Senate; Compton Criticizes Secrecy in Science; AAAS-Westinghouse Science Writing Awards	1346
Book Reviews	R. Hall and K. R. Kelson, The Mammals of North America, reviewed by G. G. Simpson; other reviews	1353
Reports	Population Size Required for Investigating Threshold Dose in Radiation-Induced Leukemia: C. Buck	1357
*	Nitrogen Partition in Excreta of Three Species of Mosquitoes:  F. Irreverre and L. A. Terzian	1358
	The Clock Paradox: C. C. MacDuffee	1359
,	Carotenogenesis and Resistance of Micrococcus pyogenes to Tetracyclines:  G. Suzue and S. Tanaka	1359
	Half-Life of Sulfur-35: R. D. Cooper and E. S. Cotton	1360
	Geographical Pattern of Crotamine Distribution in the Same Rattlesnake Subspecies: S. Schenberg	1361
	High-Energy Phosphates during Long-Term Hibernation: M. L. Zimny and R. Gregory	1363
	Factors Influencing the Effect of β-Propiolactone on Chromosomes of Vicia faba: C. P. Swanson and T. Merz	1364
	An Explanation of the Liesegang Phenomenon: C. J. van Oss and P. Hirsch-Ayalon	1365
	Prolongation of Response of Node of Ranvier by Metal Ions:  C. S. Spyropoulos and R. O. Brady	1366
Departments	Letters	1324
	Autoradiography: Meeting Notes: Forthcoming Events: New Products	1370

#### New Methods Extend the Usefulness of the Ultracentrifuge

Recent studies by research scientists have further increased the uses of the Analytical Ultracentrifuge for measuring molecular weights and purity of viruses, enzymes, proteins, polymers and a variety of organic and inorganic molecules. Here are four new developments as reported in the technical literature.



Rapid Equilibrium



Van Holde and Baldwin at the University of Wisconsin have used short liquid columns to achieve complete sedimentation equilibrium in a fraction of the time previously required. Using liquid columns of only 3 mm, they report equilibrium with sucrose in 3 ½ hours, and with a 1 mm column in only 30 minutes. In addition, the authors report that measurements during approach-to-equilibrium permit calculation of a diffusion coefficient.



If you are not familiar with the Ultracentrifuge, we will be happy to send you copies of "An Introduction to Ultracentrifuge Techniques" and the latest issue of "Fractions", a periodical sent to owners of Spinco ultracentrifuges, electrophoresis-diffusion instruments and amino acid analyzers. Write Spinco Division, Beckman Instruments, Inc., Stanford Industrial Park, Palo Alto 5, California.

Sales and service facilities are maintained by Beckman/International Division in fifty countries

Beckman Spinco Division
Beckman Instruments, Inc.

Webster says:

QUALITY means "the degree of excellence and superiority"

at Nutritional
Biochemicals
Corporation

## QUALITY

is one of our proudest assets!



Every biochemical we offer must meet or exceed our rigid Quality Control standards. Every chemical is tested for adherence to specifications. Every NBCo biochemical is of the HIGHEST possible quality commercially available . . . at the lowest possible price. In addition to our reputation for high quality at a low price, we pride ourselves in offering the FASTEST service of any research biochemicals company: all orders shipped within 24 hours of receipt, and we can even provide emergency shipments within ONE hour! Why not find out for yourself why we have become the nation's leading research biochemicals organization?

Our catalog of more than 2,500 items includes:

- Over 300 Amino Acids
- Over 90 Peptides
- More than 200 Nucleoproteins,

Purines, Pyrimidines

- Miscellaneous Biochemicals
- Vitamin

- Enzymes Crystalline
- Enzymes Purified
- Growth Factors
- Steroid Hormones
- Biological Salt Mixtures
- Biological Test Materials
- Carbohydrates
- Purified Proteins
- Fatty Acids
- Antibiotics
- Alkaloids
- Glandular Substances



ive

ing

n n

uge

ark.

OUR NEW MARCH 1959 CATALOG containing more than 2,500 items is now ready. Fill out coupon below and mail today for your free copy.

Firm or Organization

Address

City\_\_\_\_\_\_ Zone\_\_\_\_\_ State\_\_\_\_



21012 MILES AVENUE CLEVELAND 28, OHIO

SCIENCE is published weekly by the AAAS, 1515 Massachusetts Ave., N.W, Washington 5, D.C. Entered at the Lancaster, Pa., Post Office as second class matter under the act of 3 March 1879. Annual subscriptions: \$8.50; foreign postage, \$1.50; Canadian postage, 75¢.

## The Science of Mechanics in the Middle Ages

by Marshall Clagett

This noteworthy contribution to the history of science, which combines a detailed survey of the leading medieval mechanical doctrines with a collection of the basic sources themselves, offers a balanced introduction to the crucial problems of medieval mechanics. As the only summary of three generations' research in the field of medieval mechanics, this volume is invaluable both as a comprehensive introduction to a complex subject and as a convenient work of reference.

768 pages \$8.00

Plant Pathology Problems and Progress, 1908-1958

This most significant publication in the history of plant pathology contains the papers presented in International Symposia at the Golden Anniversary Meeting of the American Phytopathological Society, August 24-28, 1958. An outstanding book which contains over sixty papers by internationally-known scientists, and covers the basic principles of plant pathology as well as significant and recent advances.

624 pages \$8.50

On Numerical Approximation

Proceedings of a Symposium Conducted by the Mathematics Research Center, United States Army, at The University of Wisconsin, Madison, April 21-23, 1958.

ON NUMERICAL APPROXIMATION is comprised of the twenty-one papers which were delivered at The Symposium on Numerical Approximation conducted by the Mathematics Research Center. The objective of this symposium was the presentation and discussion of recent developments in the field of numerical approximation. The papers are centered around three general themes: Linear Approximation. Extremal Approximation, and Algorithms.

480 pages \$4.50

edited by C. S. Holton, G. W. Fischer, R. W. Fulton, Helen Hart, and S. E. A. McCallan

> edited by Rudolph E. Langer



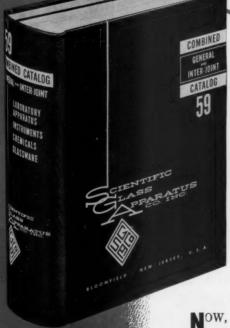
#### THE UNIVERSITY OF WISCONSIN PRESS

430 Sterling Court

Madison 6, Wisconsin

## Completely NEW from Cover to Cover!

THE MOST COMPREHENSIVE LABORATORY SUPPLY CATALOG EVER PUBLISHED!



2 SEPARATE VOLUMES
bound together for
your convenience—
separated by an
80-page index
on colored paper

1568 Pages

Thousands of

Helpful Tables
and Charts

Catalog Numbers
in Scauence

Page Headings
Alphabetized

Easy to Use

NOW, for the first time, our entire line is covered by one comprehensive catalog instead of the two volumes formerly published. An 80-page index on colored paper separates the 1132-page "General" section (scientific apparatus, instruments, appliances and general laboratory glassware and supplies) from the 356-page "Inter-Joint" section listing thousands of our regular glassware items, plus numerous other items originally fabricated to specification but now part of our regular stock.

If your laboratory does not have this new catalog, write us on your company letterhead.



#### SALES OFFICES

- · Albany 5, N. Y.
- . Bloomfield, N. J
- Baston 16, Mass.
- · Chicago 34, III.
- · Silver Spring, Md.
- Philadelphia 43, Po

announcing the

SERVALL

The latest word in automaticallycontrolled, low-temperature centrifuges



AUTOMATIC CONTROLS

SUPERSPEEDS

• RCF IN EXCESS OF 35,000 x G

CONTINUOUS FLOW

MODERN, FUNCTIONAL DESIGN

No fewer than five different rotors may be used in the new SERVALL RC-2: Superspeed, Large Capacity, Multi-Tube Superspeed, Horizontal, Virus & Particle Counting (with others under development). Gyro-Action Direct Drive: the only significant self-centering development in a decade; provides smoother operation than any other drive system. Continuous Flow System permits gallon quantities of material to be separated directly in tubes. Automatic Acceleration, Dynamic Braking, and exclusive Dual Automatic Temperature Control for accurately maintaining material temperature within ± 1°C at all times.

Write for more information about this, the Superspeed Automatic Refrigerated Centrifuge that researchers everywhere have been asking for: Bulletin SC-5RC-2.

An independent company; not connected with any other centrifuge manufacturer. ESTABLISHED 1934.

Ivan Sorvall, Inc.

DESIGNERS, MANUFACTURERS AND DISTRIBUTORS OF "SERVALL" LABORATORY INSTRUMENTS Univ Duke War

tion i

Gene

Sci

me

are

tion

of a

tive

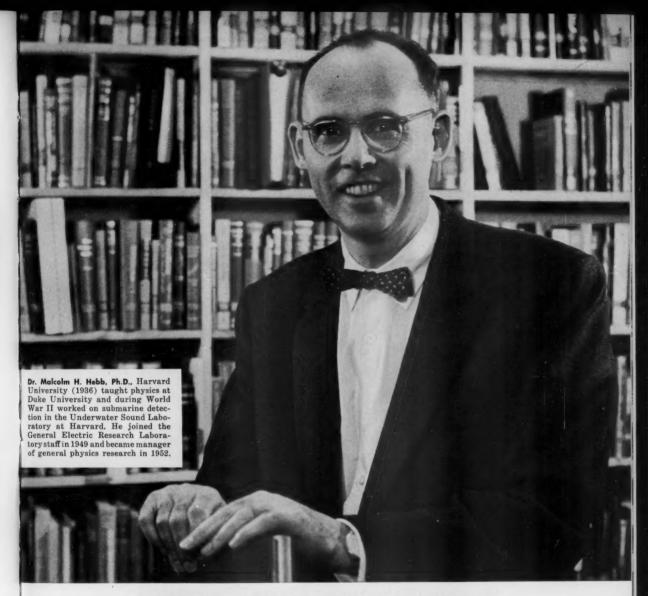
the Dr.

the

twe

pro

dir



## Freedom of inquiry

#### General Electric's Dr. Malcolm H. Hebb discusses programed and unprogramed research

Scientists in the General Physics Research Department at the General Electric Research Laboratory are engaged in fundamental studies of semiconduction phenomena, the generation of light, the behavior of arcs, and a variety of other fields. Making certain that these men and women have the tools, the incentives, and the freedom to seek out new knowledge is the particular concern of the department's manager, Dr. Malcolm H. Hebb.

Recently Dr. Hebb said: "Freedom of inquiry is the very essence of research. Conceivably, there are two idealized approaches to industrial research. On the one hand, the work may be carried out on a strictly programmatic basis, in which all of the effort is aimed directly at fulfilling immediate needs. In this approach, the horizons of tomorrow are limited by the viewpoint of today. At the opposite extreme is completely *unprogramed* research carried out in the hope that the results may somehow prove useful.

"The practical course lies somewhere between these two extremes. Actually, emphasis may shift from time to time, either from necessity or to take advantage of special opportunity. In a research program aimed at opening up virgin territory, to deny freedom of inquiry is to slam the door on discovery."

Progress Is Our Most Important Product

GENERAL ( ELECTRIC

The Applied Physics Laboratory
of
The Johns Hopkins University

Announces Appointments

#### SENIOR SCIENTIFIC STAFF

The Assessment Division of The Applied Physics Laboratory has undertaken new responsibilities and is expanding its Senior Analytical Staff. Senior Scientists in such fields as Mathematics, Physics and Physical Chemistry have in the past proven very effective in solving the types of problems involved which include analyses of tactical situations, the employment of future weapon systems and the application of the most recent advances in science and technology.

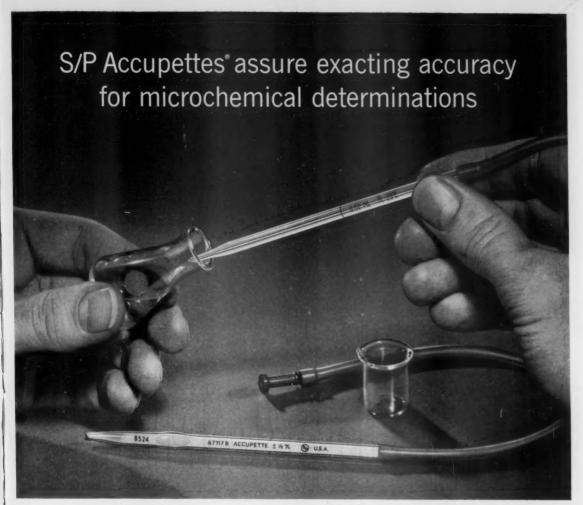
Performance of the work requires close association with scientists of other laboratories, operations research personnel of all branches of the Armed Services, and with senior military and civilian personnel.

Studies undertaken by this group will provide guide lines for the hardware research of future years. Staff members are expected to initiate ideas in support of a broad program of National Defense needs and carry them through appropriate analyses with assurance that sound results will be given consideration by the responsible agencies.

The Laboratory's locale, equidistant between Baltimore and Washington, D. C., allows staff members to select urban, suburban or rural living and either of these two outstanding centers of culture as a focal point for fine living.

These appointments offer exceptional opportunities. For information and arrangements for interview, write in confidence to:

Dr. Charles F. Meyer Assessment Division Supervisor The Applied Physics Laboratory The Johns Hopkins University 8615 Georgia Avenue Silver Spring, Maryland



## Exclusive S/P micro pipette design minimizes breakage. Clear, accurate graduations

- Ground and polished tips
- A choice of volume tolerances: regular bore ± 1%, or fine bore ± ½%
- Graduations are easy to read.
   Fused into glass . . .
   they last forever

± 1% ACCURA	CY	± 1/2 % ACCURACY 67717B Accupette, Bulb Type, Fine Bore			
67717A Accupette, No Bulb, Regu	ılar Bore				
Capacity	12, Each	Capacity	12, Each		
.01 ml. (10 lambdas)	\$0.95	.02 ml. ( 20 lambdas)	\$0.95		
.02 ml. (20 lambdas)	.94	.025 ml. ( 25 lambdas)	1.05		
.025 ml. (25 lambdas)	.94	.05 ml. ( 50 lambdas)	1.05		
.04 ml. (40 lambdas)	.95	.1 ml. (100 lambdas)	1.05		
.05 ml. (50 lambdas)	.95	.2 ml. (200 lambdas)	1.20		
		.25 ml. (250 lambdas)	1.20		

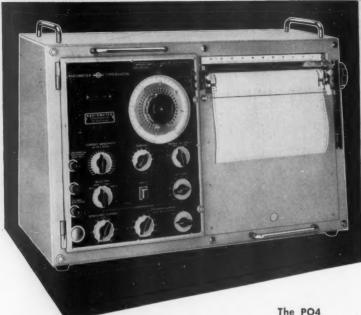
Ask the man who knows glassware best... have your S/P representative show you his samples



## **Scientific Products**

DIVISION OF AMERICAN HOSPITAL SUPPLY CORPORATION GENERAL OFFICES: 1210 LEON PLACE, EVANSTON, ILLINOIS

Regional Offices: Atlanta • Chicago • Columbus • Dallas • Kansas City • Los Angeles • Minneapolis • New York • San Francisco • Washington



a new research and control technique with vast potential

The PO4
Polariter

# POLAROGRAPHY

is a comparatively new technique offering vast possibilities in the field of chemical analysis, inorganic and organic. The measurement of diffusion current in a well defined electrolytic process makes it possible to determine the unknown component in concentrations down to 10.4 mol per liter or less. The method can be applied to any chemical system having a well defined reduction potential, and can result in determinations to a fraction of a microgram per gram of solution.

The Radiometer PO4 Polariter is a mains operated unit, presenting polarographic traces of high sensitivity and resolving power on built-in direct pen recorder. Provision for derivative and peak polarograms, damping, condenser current compensation, and maximum sensitivity of .00008 microamperes per mm. on a 250 mm. recording width, makes the PO4 a complete and versatile instrument, ideal for series determinations utilizing unskilled laboratory help. Let us know and we will be happy to send you complete catalogue and literature. Radiometer PO3, more modestly priced for less stringent applications, is also available.

If you wish to receive the Radiometer quarterly journal POLARO-GRAPHICS, containing literature reviews and current polarographic abstracts, please advise us.

SOLD AND SERVICED IN U.S.A. BY

WELWYN INTERNATIONAL INC.

cliff Terroce CLEVELAND 11. OH



**RADIOMETER** 

72 Emdrupvej

CODENHACEN DENMARK

In Canada: Contact any Branch of Conadian Laboratory Supplies Limited

#### ... NEWS IS HAPPENING AT NORTHROP

# Solving Problems of Manned Space Flight at Northrop

by Welko E. Gasich

Director of Weapon System Development Engineering, Norair Division of Northrop Corporation, Hawthorne, California



Man in space. To put him there and return him safely to earth, no scientific breakthroughs are needed. It is now a problem of engineering. Engineers must solve lunar space challenges that include reliability, radiation, and human environment problems. Man himself must be trained for the environmental problems associated with either boost-glide or ballistic recovery. These are the areas in which the scientist and the engineer at Northrop are working today.

The outstanding man may work in several product areas at Norair Division — aircraft, missiles, and space vehicles.

System engineers in Norair's Astronautics Department work on close orbit systems, lunar orbit systems, interplanetary space systems, and galactic space systems. Scientists work in various fields of technology associated with space flight. In astrodynamics, for example, their areas may include celestial mechanics and trajectory analysis. In astronavigation, the problems of inertial guidance, star

tracking, and horizon scanning are paramount. In astrophysics, the Norair scientist employs the disciplines of astronomy, magnetic field physics, and aerophysics. Space propulsion research and development finds applications of nuclear propulsion systems, ionic and plasma microthrust systems.

An incalculable aid for the Norair technician are the facilities of the Northrop Corporation and Norair's own recently completed four-million-dollar test laboratories. Norair's high-grade equipment will include hypersonic and shock tunnels.

Such outstanding facilities augment other Norair advanced design studies for the space age. Current among these are the Satellite Rendezvous Program and special projects that include space vehicles for reconnaissance applications—for civilian as well as military use. Recent projects for the U.S. Government—particularly in the field of operations analysis—have proved measurable contributions.

Northrop constantly translates

advanced technologies into simplified applications — creating answers to complex problems that assure a high degree of reliability at low cost. One recent example at the Norair Division is the N-156F supersonic fighter. Weighing half as much as comparable U.S. fighters, it uses only half the fuel — to deliver equivalent performance for free-world defense.

Current papers by Northrop scientists and engineers include:

Lightweight High-Performance Military Aircraft—W. E. Gasich; Problems Associated with Injecting, Orbiting, Recovering A Man from Space Flight—Ralph Hakes.

For copies of these papers and additional information about Northrop Corporation, write:

## NORTHROP

Dept. T-1300-32, P.O. Box 1525 Beverly Hills, California

## THE N. I. L. FLAME PHOTOMETER

- formerly the Patwin Model FC -

## STILL THE BEST!

FOR
SENSITIVITY,
REPRODUCIBILITY,
TROUBLE-FREE USE,
LOWEST COST

Send for Bulletin FC and free copy of extensive bibliography on Flame Photometry



#### THE FEATURES CONFIRMED BY HUNDREDS OF LABORATORIES:

- Three matched photoelectric cells provide optimum spectral response and decrease cell mortality.
- Compact horizontal burner gives uniform flame pattern.
- Unique double glass and copper chimney system, plus internal blower, insures thermal stability.
- External atomizing chamber removable for easy maintenance and cleaning.
- Built-in automatic gas regulator and controlled atomization give uniform combustion and excitation.
- Sturdy cast aluminum housing.

#### TO USERS OF BARCLAY AND PATWIN FLAME PHOTOMETERS:

All servicing, parts, and accessories for the Barclay Flame Photometer and the Patwin Model FC are now obtainable from National Instrument Laboratories or from authorized representatives.

#### NATIONAL INSTRUMENT LABORATORIES, Inc.

Manufacturers and Designers of Scientific Apparatus

828 EVARTS ST., N.E., WASHINGTON 18, D.C.

Tel. NOrth 7-7582

11



## recti/riter systems offer you the widest recording ranges available

Versatile "recti/riter" recorders, both Single and Dual channel, have established new standards for reading ease, full-scale accuracy, and up-front operator conveniences. Now, the applicability of the "recti/riter," or other graphic recorders of one-milliampere sensitivity, is extended to the widest practical limits by the use of Series 300 accessories, which presently include models:

301 DC AMPLIFIER

350 MULTI-VOLTAGE MONITOR

351 AC MULTI-CURRENT MONITOR

352 LINE FREQUENCY MONITOR

353 LINE VOLTAGE MONITOR 354 LINE CURRENT MONITOR

333 LINE SERVICE MONITOR (a single-package combination

of 352, 353, and 354) Only the "recti/riter" systems, recorders and matching accessories, offer these wide ranges for recording

electrical parameters: 10 millivolts to 1000 volts . . . 500 microamperes to 1000 amperes . . Monitor standard frequencies-40, 60, 400 cps. FULL SCALE RANGES—Accessory scales give quantities per division equal to decimal multiples or sub-multiples of 1, 2, and 5 in keeping with standard 50-division chart of recorders.

ACCURACY—Combined recorder-accessory response departs from true value at any point not more than 2 per cent of the full scale value.

POWER REQUIREMENTS-No auxiliary power required for transducer accessories . . . a 45-volt battery or optional AC supply is used with the DC Amplifier.

SIZE-Aluminum cases 21/2" H., 71/2" W., 10" D. (Monitors may be mounted inside as integral part of recorders.) Mountings are available for relay racks, flush mounting, portable, or desk use.

To select the "recti/riter" recorder-accessory system that meets your exact measurement requirements, let TI give you complete technical assistance . . . write or call today!



## TEXAS INSTRUMENTS

INDUSTRIAL INSTRUMENTATION DIVISION

3609 BUFFALO SPEEDWAY . HOUSTON, TEXAS . CABLE: TEXINS

#### OTHER TI/IID PRODUCTS

- Complete Geophysical Instrumentation
- DATA-MAC Measurement and Control Systems
- Automatic Test Equipment

## 3 Saunders texts to encourage student interest in science



#### New (2nd) Edition!

## Luder, Vernon & Zuffanti — GENERAL CHEMISTRY

New (2nd) Edition—This rigorous freshman text integrates recent developments in chemistry without including difficult details. Experimental facts are given first, before the theory designed to explain them. After introduction of periodic charts, arrangement of subject matter is determined by arrangement of elements in the periodic table. Text material has been extensively revised with signifi-

cant changes in the chapter on acids and bases. The treatment of this subject is historical. A more exact presentation of the theory of electrolytic solutions is given than in the previous edition. Many new problems have been added to each chapter.

By WILLIAM F. LUDER, Ph.D., ARTHUR A. VERNON, Ph.D., and SAVERIO ZUFFANTI, Professors of Chemistry, Northeastern University, Boston. 582 pages with 149 illustrations, \$6.75 New (2nd) Edition!

#### Frobisher — Fundamentals of MICROBIOLOGY

Sixth Edition—Here is a clear presentation of every aspect of microbiology for the beginning student. It furnishes a firm foundation upon which the student may build for specialization in a great number of fields—medicine, home economics, botany, chemistry, physiology, engineering, etc. The principal characteristics of the 8 major groups of microorganisms are simply explained. Structure, growth and habitat of each group are discussed in detail. The student learns how these microorganisms, especially bacteria and viruses, exemplify the basic

principles of biology, such as reproduction and growth, metabolism, genetics, variation and mutation. The author explains and outlines methods used in the observation, propagation and study of microorganisms and illustrates their role in nature.

By Martin Frobisher, Jr., Sc.D., Special Consultant, Bacteriology Branch, Communicable Disease Center, U.S. Public Health Service, Chamblee, Georgia; Associate Professor of Bacteriology, Emory University; Visiting Lecturer, Johns Hopkins University School of Hygiene and Public Health. 617 pages, with 224 illustrations, some in color. \$6.50.

#### Giese — CELL PHYSIOLOGY

Written in simple language and bold outline this text is geared to the undergraduate student. It describes the major problems of cell physiology—explaining their interrelationships and the current status of each. The author avoids treatment of problems which relate to the organization of cells into organisms, thereby making this book a closely-knit body of information which can be presented to a one-quarter or one-semester class.

The eight sections of the text cover: the scope of cell physiology; cellular environment; the cell and protoplasm; exchange of material across the cell membrane; nutrition; irritability and response; protoplasmic growth and cell division; and history of cell physiology.

By Arthur C. Giese, Ph.D., Professor of Biology, Stanford University, 534 pages, with 259 illustrations. \$10.00.

Gladly sent to college teachers for consideration as texts.

W. B. SAUNDERS COMPANY

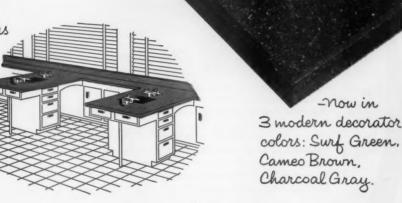
West Washington Square,

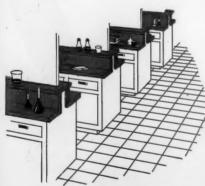
Philadelphia 5

For hard-working laboratory surfaces

a bright new touch of personality...

In school and college laboratories, Colorlith table tops stay attractive after years of abuse.





In leading industrial labs, Colorlith combines finest working conditions, unusual durability, low cost.

## J-M COLORLITH®...handsome, tough, colorful

Now, no matter what the work load, laboratories can be bright, colorful, pleasant places to be in. This completely inorganic material, properly coated with a clear lacquer or equivalent to meet specific service requirements, gives table tops greater toughness and durability than natural stone—at lower cost.

Fabricated from asbestos fiber, Portland cement, and chemically resistant colorings which run all the way through the sheet, Colorlith withstands heat, flame, moisture . . . acids and solvents in working concentrations. It comes in large 4' x 8' sheets which can be cut in any shape. Thicknesses range from  $1\frac{1}{4}$ " all the way down to  $\frac{1}{4}$ ";  $\frac{1}{4}$ " can be used safely because of great uniform strength.

Write for Colorlith specification sheet EL-94A and brochure EL-62A. Johns-Manville, Box 14, New York 16, New York. In Canada, Port Credit, Ontario.

JOHNS-MANVILLE



MEASURING INSTRUMENTS

8 AU

#### A resolving power better than 15 AU

is guaranteed for the Electron-Microscope

#### **ELMISKOP**

designed for normal routine work and for special research problems in science and industry.

#### Special features:

Beam voltages 40, 60, 80 and 100 kv.

Direct magnification continuously variable from 200 to 160,000 times.

Fine-focus condenser for transmission of smallest specimen regions down to a diameter of 3 microns.

Adjustable magnetic stigmators in condenser and objective.

Transmission microscopy (bright- and dark-field, stereoscopic and selected area micrographs).

Diffraction (normal transmission diffraction with and without lenses, high-resolving diffraction, reflection diffraction for conducting specimens, simultaneous diffraction, selected area diffraction).

Universal diffraction unit with heating device (optional).

Object cooling stage (optional).

For work in the industrial field and medical research the simplified design

#### **ELMISKOP II** is of increasing importance:

Resolving power better than 25 AU. Beam voltages 40, 50 and 60 kv.

Direct magnification up to 30,000 times.

Accessories for specimen preparation: Vacuum Evaporating Unit

11-kc Emulsifier

Resolution test with evaporated palladium direct magnification 100,000 times total magnification 1,000,000 times

SIEMENS & HALSKE AKTIENGESELLSCHAFT
BERLIN - MONCHEN

SIEMENS NEW YORK INC.

350, FIFTH AVENUE . NEW YORK 1, N.Y. . TELEPHONE: LONGACRE 4-7674

THE AHEARN & SOPER CO.LTD.

OTTAWA (CANADA) . P.O. BOX 715 . TELEPHONE: C 34068

SCIENCE, VOL. 129



REFRIGERATED CENTRIFUGE

NOW . . . with AUTOMATIC ACCELERATION . . . ADDED ACCESSORIES

This unique combination of large capacity, higher speed and lower controlled temperature increases the value of centrifugal force as a basic research tool.

force as a basic research tool.

HIGH "G" HEADS: The 8-place 50 ml head delivers 40,000 x G;
the 6-place 250 ml head, 26,000 x G. Adapters are available for
the 6-place 250 ml head, 26,000 x G. Adapters are available for
use with smaller tubes. Additional heads and attachments are
use with smaller tubes.

being developed.

HIGH SPEEDS are obtained by a direct drive, special motor.

Speeds are set by a stepless autotransformer control.

TEMPERATURES BETWEEN  $-20^{\circ}\text{C}$  and  $+40^{\circ}\text{C}$  are kept constant within  $\pm 1^{\circ}\text{C}$  by a 1 HP refrigeration unit, an exclusive fin-coiled evaporator, and a new combination of plastic foam and fibre glass insulation.

USE THE COUPON to get all the facts about this all-new and better high-speed refrigerated centrifuge from International . . . Your Dependable Source for Centrifugal Force.

## INTERNATIONAL IEC EQUIPMENT CO.

1219 SOLDIER'S FIELD ROAD, BOSTON 35, MASS., STadium 2-7900 Please rusb complete data, on International's new HR-1 High-Speed Refrigerated Centrifuge with automatic acceleration and added accessories.

Name ..... Title ....

Street & No. ..... City Zone State

Space Technology Laboratories is responsible for the over-all systems engineering, technical direction and related research for the Air Force Intercontinental and Intermediate Range Ballistic Missile Programs and for the highly successful Thor-Able series of ICBM range re-entry launches. In addition, STL carries out special experimental projects for such agencies as the National Aeronautics and Space Administration and the Advanced Research Projects Agency. On behalf of these agencies and in conjunction with the Air Force Ballistic Missile Division, STL designed and produced the Pioneer I payload, one of the most sophisticated fact-finding devices ever launched into space. In addition, STL provided systems engineering and technical direction for the Air Force satellite, the Atlas SCORE. In support of these and future requirements, STL's activities provide a medium through which scientists and engineers are able to direct their interests and abilities towards the solution of complex space age problems. STL invites inquiries regarding staff openings in any of the five major areas of the company's activities.

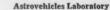
#### Electronics Laboratory

...provides technical direction for, and conducts studies leading to, design and specifications of advanced guidance, control, and communication systems; also packaging, environmental testing and over-all checkout.



#### Physical Research Laboratory

... conducts basic research including analytical and experimental investigations in magnetohydrodynamics, ther monuclear power, plasma physics, and low temperature solid state physics.



... conceives, evaluates, designs, develops, and tests space vehicle systems; provides technical direction of propulsion, nose cone, and airframe subsystems; explores new propulsion, airframe, re-entry, and ground handling techniques.



Computation & Data Reduction Center ... provides a centralized mathematical and computing facility and engages in advanced research in data systems, information theory computes.

engages in advanced research in data systems, information theory, computation systems and automatic programming, systems and hardware simulation, and applied mathematics.



Systems Engineering Division

...has the over-all responsibility for the system integration of the Atlas, Titan, Thor, and Minuteman weapons systems, in addition to responsibility for technical direction of the airframe, sub-system, assembly and test, and ground support activities; evaluates proposed future weapons and space systems.







S-29700 Spectro-Electrometric Titration Apparatus—Model SE, SARGENT-MALMSTADT..

#### For SPECTROPHOTOMETRIC TITRATIONS

Provides direct automation of most titrations now being performed which inherently or in conjunction with an indicator provide a spectrophotometric end point. These include acid-base, oxidation-reduction, complex formation and some precipitation reactions, indicators being available for most of the titrations currently performed by manual methods.

#### For ELECTROMETRIC TITRATIONS

Provides facilities to perform automatic derivative potentiometric titrations as performed by the S-29690 SARGENT-MALMSTADT automatic potentiometric titrator. Provision is made for the convenient connection of simple circuits for constant current potentiometric, "polarized electrode" and similar titrations.

For complete information contact your nearest Sargent Division or write: Dept. SE, Chicago, Illinois

## SARGENT SCIENTIFIC LABORATORY INSTRUMENTS • APPARATUS • SUPPLIES • CHEMICALS

E. H. SARGENT & COMPANY, 4647 W. FOSTER, CHICAGO 30, ILLINOIS DETROIT 4, MICH. . DALLAS 35, TEXAS . BIRMINGHAM 4, ALA. . SPRINGFIELD, N. J.



#### Letters

#### Teaching and Research

Impressed by what Caplow and Mc-Gee bring out in their book The Academic Market Place [see Science 129, 357 (1959)], Victor G. Fourman deplores the deemphasis on teaching ability and the concomitant stress on publication in the academic evaluation of college professors. With this aspect of Fourman's argument I most heartily agree. Unless he be frankly engaged as a research professor, no member of a college or university faculty should be advanced on the basis of publications alone.

However, in all the literature I have seen on this troublesome subject there is little or no mention of what seems to me the really critical thing in the whole question of teaching versus researchthe one valid reason why department heads, deans, and presidents may be justified in demanding that a faculty man publish. Unless a college teacher is actively engaged in grappling with the unknown somewhere on the forefront of knowledge, he will not bring into the classroom the point of view, the frame of mind, the mode of attack, the general air of the investigator, and these qualities are just what is essential if a teacher is to show, in the presence of the student, by various forms of example, how to go about dealing with the problems in his subject.

These remarks are directed mainly at the problem of college teaching—teaching in the undergraduate world. Graduate work deserving of the name is concerned with educating the student in the ways of original investigation, and to put a noninvestigator in charge of such work is indeed asking the blind to lead the blind. But even here the investigator should be a good teacher, not necessarily in the way that his colleagues in the undergraduate field are good teachers—and in fact there is often a difference—but a good teacher nevertheless.

Now it is publication that is nearly always emphasized in this picture and, unfortunately, not always research; this is one vice of which Fourman justly complains. Quality of publication should of course take first place in any individual evaluation, for the prime value of publication itself, in this context, is the evidence it affords that the author is really an investigator. Over and above all the cant and hypocrisy that have, regrettably, invested much discussion of the matter, the valid case is after all rather simple: A man can hardly go very far in sound research without finding out something new, and when he does he owes it to his fellow scholars to make known the results of his work.

And there is also the negative side of the picture. If a teacher does no more than read and absorb the literature on his subject (this he must do as minimal preparation) it is highly likely that in the course of a few years he will go stale in his own thinking.

And finally, all this must probably be qualified by the truism that in a broad field like college teaching all kinds of genius are needed. Many years of association with many kinds of teachers have brought me to realize that there probably are some people who can stimulate students in certain desirable ways without doing any kind of research. But for the reasons given above, in view of the essential fact that the main thing college can do for a student is to show him how to learn and how to think, such teachers should be the exception and not the rule. Men and women who can do a good job of both teaching and research are probably not as rare as many would have us believe.

EDMUND M. SPIEKER Department of Geology, Ohio State University, Columbus

#### Department of Science

I should like to express my strong approval of the article on "Government sponsorship of scientific research" by L. V. Berkner [Science 129, 817 (1959)].

Like many members of the scientific community I have had grave doubts about the wisdom of setting up a federal department of science headed by an officer of cabinet rank. Increasingly, however, I have become convinced that such a department is practically a necessity, if science is to play the role that it must play in any vigorous society today. Berkner's article provides the most powerful argument that I have seen in favor of such action, and to me the argument seems practically unanswerable.

As regards the scope of such a department I should go along with Berkner's argument almost entirely except that I should like to see the National Science Foundation included in the proposed department. It is true that its inclusion would modify the structure, and expand the responsibilities, of the department, as envisaged by Berkner. I believe, on the other hand, that the National Science Foundation would probably flourish more vigorously and obtain more adequate support if it were a part of a federal department of science. The foundation has hitherto been almost a stepchild of the government. Its functions are of enormous importance; it should be the government agency with prime responsibility for the promotion of fundamental scientific research in this coun-

(Continued on page 1369)

## Announcing



## **Carl Zeiss Research Microscope**

## **Model WL**

of ore on

in ale be ad of

obate thfor

olim ich ind and re-

ny

apent L.

o)]. cific abts fed-

by

gly, hat

ces-

t it

lay. ow-

vor

arter's

ence desion and ent,

on Sci-

rish ade-

fedountepions

ould

ime

fun-

oun-

. 129

## A new, versatile, precision instrument

The latest optical and mechanical achievements are incorporated in the new Research Microscope WL.

It is designed to meet today's demands of the microscopist for versatility and comfort in manipulation. This microscope is well suited for microscopic observation in brightfield, darkfield, phase contrast, polarized light as well as incident light.

Write for free illustrated booklet describing this outstanding instrument



Made in West Germany

CARL ZEISS, INC.

485 FIFTH AVENUE, NEW YORK 17, N. Y.

GUARANTEED UNINTERRUPTED REPAIR SERVICE

## announcing the Eldorado 4100

## A Fast, Stable Pulse Height Analyzer



Full size view of one channel showing register and two decades

## How Fast?

- \* Double pulse resolution better than 0.5 microseconds
- \* Dead time less than 0.1 microseconds
- \* Average counting rates greater than 105 counts per second without baseline distortion or use of temporary storage

## How Stable?

- \* Channel width less than 1 % drift per week
- \* Baseline less than 0.1% shift per week
- \* Channel triggering level unaffected by changes in input pulse width

For complete details, call your nearby Eldorado Engineering representative or write Dept. S5

#### BRIEF SPECIFICATIONS

Power Supply PS-530

NUMBER OF CHANNELS 20

CHANNEL WIDTH 1.0V NOMINAL

fornia. Shown with optional LA-600 Linear Amplifier and optional High Voltage

SCALER CAPACITY 106 COUNTS/CHANNEL

WINDOW AMPLIFIER INPUT

20V NOMINAL

WINDOW POSITION RANGE 5-105V

## Eldorado Electronics

2821 TENTH STREET . BERKELEY 10. CALIFORNIA

Phone THornwall 1-4613

## SCIENCE

## AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

#### Board of Directors

PAUL E. KLOPSTEO, President
CHAUNCEY D. LEAKE, President Elect
WALLAGE R. BRODE, Retiring President
H. BENTLEY GLASS
GEORGE R. HARRISON
MARGARET MEAD
THOMAS PARK
DON K. PRICE
MINA REES
WILLIAM W. RUBEY
ALAN T. WATERMAN
PAUL A. SCHERER, Treasuret
DAEL WOLFLE, Executive Officer

DAEL WOLFLE, Executive Officer GRAHAM DUSHANE, Editor JOSEPH TURNER, Assistant Editor ROBERT V. ORMES, Assistant Editor

#### **Editorial Board**

DONALD J. HUGHES H. BURR STEINBACH
KONRAD B. KRAUSKOFF WILLIAM L. STRAUS, JR.
EDWIN M. LERNER EDWARD L. TATUM

#### Editorial Staff

JUNE G. BANDY, SARAH S. DEES, LUCILLE GUINARD, NANCY S. HAMILTON, WILLIAM HASKELL, OLIVER W. HEATWOLE, YUKIE KOZAI, ELLEN E. MURPHY, BETHSABE PEDERSEN, MADELINE SCHNEIDER, NANCY L. TEIMOURIAN, MARIA A. WOLSAK.

EARL J. SCHERAGO, Advertising Representative

SCIENCE, which is now combined with THE SCIENTIFIC MONTHLY, is published each Friday by the American Association for the Advancement of Science at Business Press, Lancaster, Pa. The joint journal is published in the SCIENCE format. Entered at the Lancaster, Pa., Post Office as second class matter under the Act of 3 March 1879, SCIENCE is indexed in the Reader's Guide to Periodical Literature.

to Feriodical Literature.

Editorial and personnel-placement correspondence should be addressed to SCIENCE, 1515
Massachusetts Ave., NW, Washington 5, D.C.
Manuscripts should be typed with double spacing and submitted in duplicate. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors. For detailed suggestions on the preparation of manuscripts, book reviews, and illustrations, see. Science 125, 16 (4 Jan. 1957).

Dividual descriptions convergence about does

Display-advertising correspondence should be addressed to SCIENCE, Room 740, 11 West 42 St., New York 36, N.Y.

Change of address notification should be sent to 1515 Massachusetts Ave., NW, Washington 5, D.C., 4 weeks in advance. If possible, furnish an address stencil label from a recent issue. Be sure to give both old and new addresses, including zone numbers, if any.

Annual subscriptions: \$8.50; foreign postage, \$1.50; Canadian postage, 75¢. Single copies, 35¢. Cable address: Advancesci, Washington.



#### Science Writing Awards

The interpretation of science to the public is an activity of such high importance that we are glad indeed to announce that the AAAS is again sponsoring two annual awards of \$1000 each for excellence of science writing. One award will be made for newspaper and the other for magazine articles. Funds are being supplied by the Westinghouse Educational Foundation. General management is in the hands of the AAAS and a committee representing the three sponsoring organizations, the Westinghouse Electric Corporation, the National Association of Science Writers, and the AAAS. Announcements and rules of eligibility are being distributed to science writers and to newspapers and magazines. The rules are given on page 1348. Entry blanks may be secured from the AAAS. Because excellence of medical reporting is already recognized by the Lasker Awards, writing in the clinical medical field will not be eligible. The new awards are therefore complementary to the Lasker Awards.

A panel of judges representing newspaper and magazine editors, schools of journalism, science, and the general public will select the winning entries. Winners will be informed early in December, and the awards will be presented during the AAAS annual meeting at the annual dinner of the National Association of Science Writers.

Improving the communication of science to the public is a AAAS responsibility that we have not been carrying out as well as we should like. The new awards are one aspect of what we hope will be a more effective program. Fortunately, other organizations are also interested in improving science reporting. The British Association for the Advancement of Science is one that is trying out a rather different approach. Three special lectureships have been established, tenable only by comparatively young scientists who have demonstrated exceptional skill in lecturing to general audiences. Each year the three lectures will be given at the annual meeting of the British Association, and may be repeated later in other cities.

The British Association lectureships are—if the term may be used—for talented amateurs. The AAAS-Westinghouse Awards, in contrast, will probably usually go to professional science writers. That both groups include members with real talent for popularizing science is evident from the list of winners of UNESCO's annual Kalinga Prize. American winners of this award have been Waldemar Kaempffert and George Gamow. Karl von Frisch was last year's winner, and a particularly worthy one, for he has not only provided a wide audience with accounts of interesting zoological work, but in some of his writing, for example Bees, Their Vision, Chemical Sense, and Language, has also done the more difficult task of conveying to the general reader a beautifully clear picture of the mode of thought, the point of view, and the interplay of hyopthesis and experiment that characterize scientific work.

There is nothing in the rules of the AAAS-Westinghouse Awards to prevent a scientist from winning. In fact we hope that once in a while a dyed-in-the-wool scientist will be announced as the winner. But any scientist will face stiff competition, for there is a growing body of highly competent professionals in the field.

Whoever wins, this new program will provide an opportunity to reward excellence in an activity that is of importance both to science and to society.—D.W.

# "We Count More Samples . . . Count For Longer Periods . . . And Still Have More Time For Research"





This is a typical quote from research personnel in laboratories where Packard Tri-Carb Spectrometers and/or Auto-Gamma Spectrometers are used.

These instruments are completely automatic. They handle up to 100 samples and record all data (sample number, time and scaler counts) accurately and permanently on paper tape. Operation can be maintained on a 24-hour basis. No staff time is required for counting. Consequently, laboratory personnel have more time for other important research work.

If you are counting radioactive samples, learn how Packard can improve your experimental data and still save you time. Contact Packard Instrument Co., Inc. Request latest bulletin on the Tri-Carb Liquid Scintillation Spectrometer and/or the Auto-Gamma Spectrometer.



## SCIENCE

#### Push to the Desert

The pressure of agriculture on California's arid lands illustrates the law of diminishing returns.

Howard F. Gregor

One-third of the land surface of the earth has a dry climate, and these lands comprise the largest area of any of the climatic regions. It is not surprising, then, that with the present rapid increase in populations, the densely populated areas of the world are pressing ever more intensely on the margins of the dry lands. Most considerations of such pressure have emphasized Southeast Asia, North Africa, and the Middle East, where population densities are extremely high and living standards are correspondingly low. But the crowding of agriculture and populations on the rims of the dry regions is no longer uncommon in the more economically advanced and less densely populated countries, such as the United States and the Soviet Union. In the United States, for example, while cropland area has remained fairly static in most sections of the humid East since 1920, it has significantly increased in the drier West. Population has also grown more rapidly in the West.

The focal point of these "pressures" on the dry lands of the United States is California. One can appreciate this more fully if he considers that this state currently leads all others in rate and amount of population increase, in farm production and expenditure, and in irrigation, and yet has a sizable portion of the driest section of North America. The growth of irrigation farming in California therefore provides us with an excellent example of pressure on arid lands in an area where living standards are uniformly high and agricultural technology is well

advanced—a situation quite in contrast to that in most countries of the world where dry conditions are encountered.

#### **Extent of California Dry Lands**

Drought, in varying degrees, is common to almost all agricultural land in California (Fig. 1). Since croplands, or potential croplands, correspond generally to the lowlands, it is relatively simple to denote them by geomorphic terms (Fig. 2). The San Joaquin Valley and the Southeast Desert are the driest and, simultaneously, the largest of the California lowlands. These areas also include about 60 percent of the irrigable area of the state. Despite the difference in the terms used to describe their land forms both areas are definitely deserts from the standpoint of moisture deficiency, being classified as "arid" by Thornthwaite (1). Not quite as dry are the "semiarid" portions: the northern tip and eastern piedmont of the San Joaquin Valley, the Central Coastal Valleys between San Francisco and Santa Barbara, and the South Coastal Valleys. The Sacramento Valley and the Northeast Interior Basins and Valleys are even less dry ("dry subhumid") but still belong to the moisturedeficient group. Unfortunately, the last two regions named include only about 20 percent of the irrigable land in the state.

Only the several small lowlands of the North Coastal Valleys ("moist subhumid" or "humid") are judged to have sufficient moisture for agriculture. But these areas contain just 3 percent of the total agricultural land in the state, which, it is estimated, can eventually be irrigated if all the water available is utilized. Thus, even here, water supplies supplemental to the normal water supply are considered desirable, for even in the most humid portions of California drought conditions are approached for at least 2 months during the summer.

#### Areal Expansion of Irrigation

Beginnings of irrigation: 1848-1870. Some historians of agriculture still disagree on the question whether it was the early California miners-turned-farmers or the Mormons of Utah who introduced modern irrigation to the West. In any case, there is no question but that the forty-niners were the first group of any size to initiate "American" irrigation farming on a serious scale in California. Whereas the irrigation sites of the early missions were established along the central and southern California coast, most of the first irrigation projects of the "Anglos" were in the interior: the Sierra Nevada streams were tapped to water small, scattered croplands located principally along the eastern margins of the Sacramento Valley; like the irrigation projects of the missions, the projects of the Americans were developed only in semiarid areas. Only in the late 1800's and around the turn of the century did irrigation farming seriously invade the drier areas of the San Joaquin Valley and southeastern California.

Historical circumstance, rather than severity of drought, was actually the determining factor in the choice of initial locations for irrigation developments in California. The Spaniards considered primarily ease of access to coastal locations and the necessity for establishing centers from which political and religious control could be effectively exercised, whereas the American settlers concentrated their first irrigation projects close to the rapidly expanding markets provided by the gold-field populations. By 1870 other irrigated patches had developed, notably in the small northeastern semiarid portion of the San Joaquin Valley and in the South Coastal Valleys. To be sure, several centers of irrigation,

The author is associate professor of geography at San Jose State College, San Jose, Calif.

Table 1. Amounts of irrigated and irrigable land in California, 1889–1954. All figures except those in the last column are from statistics published by the U.S. Bureau of the Census. The division of acreage among the coastal (South Coastal Valleys) and interior (Southeast Desert) portions of Los Angeles, San Bernardino, and Riverside counties for 1889, 1899, 1939, and 1954 was determined from "Water utilization and requirements of California" [Calif. State Water Resources Board Bull. 2 (1955), vol. 1, pp. 193, 211]; from "Memorandum report on water conditions in Antelope Valley" [Calif. Div. of Water Resources Publ. (1955), pp. 13, 18]; and from the agricultural commissioners' reports for Los Angeles, San Bernardino, and Riverside counties, respectively. Lack of readily available statistics made apportionment for the year 1919 more difficult, and only rough estimates of acreage were made. Maximum irrigable acreage was computed from Calif. State Water Resources Board Bull. 2 and from L. R. Wohletz and E. E. Dolder, Know California's Land (State Printing Office, Sacramento, 1952).

Region	Irrigated area (10 <sup>s</sup> acres) in years indicated					Maximum irrigable
Region	1889 1	1899	1899 1919	1939	1954	area (10° acres)
San Joaquin Valley	469	749	2,059	2,490	3,739	6,749
Southeast Desert	46	41	539	516	674	4,000
Sacramento Valley	107	122	598	797	1,280	2,852
Northeast Interior Basins						
and Valleys	214	240	252	297	294	1,321
Central Coastal Valleys	9	57	200	351	490	1,215
South Coastal Valleys	153	227	554	594	495	1,024
North Coastal Valleys	4	6	11	23	79	552
Total	1,002	1,442	4,213	5,068	7,051	17,713

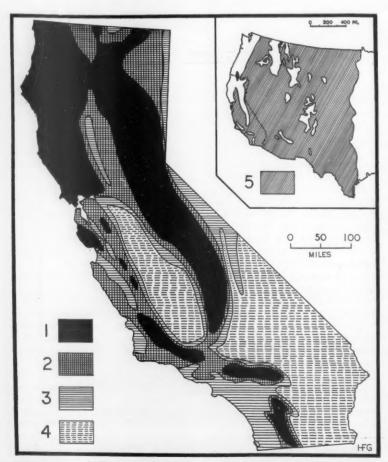


Fig. 1. Moisture regions of California: (1) areas of sufficient moisture; (2) dry subhumid areas; (3) semiarid areas; (4) arid areas; (5) moisture-deficient area of the West. [Generalized after Thornthwaite (1)]

remnants of the older mission enterprises, still existed at this time and were dispersed along the central and southern California coast from the San Francisco Bay region to San Diego. At no time, however, were these projects very large. Irrigation in California in 1870 involved only about 60,000 acres, yet this was many times the largest acreage the missions had ever watered. In no year, apparently, did the mission-cultivated acreage exceed 5000 to 10,000 acres, and much of that acreage was never irrigated.

Major expansions: 1870-1880. Extensive development of irrigation in California dates from the period 1869-1870, when the Central Pacific Railroad extended its tracks through the San Joaquin Valley. More land was then opened up to settlers, and, for the first time, relatively fast and dependable transportation was established between California and her rapidly expanding eastern markets. Soon all the major streams emanating from the Sierra Nevada became important centers for diversion of water onto the expanding croplands of the eastern and northern margins of the San Joaquin Valley. The first large irrigation system was constructed in 1871: a 40-mile-long canal was built to tap the San Joaquin River west of Fresno for irrigating lands northwest of the city. This project was followed by extensive canal construction in other portions of the San Joaquin Valley, again principally in the eastern half. Irrigation expansion also moved apace in the coastal lowlands of southern California, Thus, in the decade 1870 to 1880, there was not only sizable expansion of the irrigated acreage of the state but also an increasingly greater concentration of irrigation activity in the drier lands. The San Joaquin Valley forged ahead of the Sacramento Valley, and even semiarid coastal southern California began to challenge the Sacramento Valley in extent of irrigated lands (Table 1).

New irrigation activity during this period was by no means restricted to the Sacramento and San Joaquin valleys and the South Coastal Valleys. An increasing number of the scattered small lowlands in the mountains north and northeast of the Sacramento Valley were being "put to the ditch" (Fig. 3). Actually, it was not until around the turn of the century that such important irrigation farming areas as the Sacramento Valley and the coastal areas of southern California even equalled this northeastern section, the Northeast Interior Basins and Valleys complex. Such remarkable early devel-

opment for a section of relatively limited lowland was more apparent than real, however. In addition to the lower temperatures, which precluded planting of the more intensively cultivated crops peculiar to most of the other dry lands in California, there was the problem of a much shorter growing season, which eliminated any possibility of double cropping, another feature now common to most of the dry-land regions where temperatures are milder.

d

d

r-

r-

n

18

e.

10

7e

of

i-

ıs.

as

ri-

m

r-

ne

ne

id

to

x.

he

nd

ds

of

ut

as

ry

ng

he

en

he

el-

129

Irrigation had already begun, too, at this early date in the southeastern desert region. But most of the irrigated cropland of the region was concentrated in the relatively cool Owens Valley, in the extreme northern portion. The rest of the southeastern desert corner of California was still largely a void on the agricultural map. Irrigation was expanding also, at a very moderate rate, in the parallel valleys of the coastal ranges between the San Francisco Bay and the Los Angeles areas. Even in the lowlands north of the Bay region-the only cultivable lands in California where moisture is not critically deficient-modest amounts of land were being added to the total acreage under irrigation. By 1880, the total irrigated acreage in California had increased sixfold over that of 1870, and 292,885 of the 350,000 irrigated acres were in the Sacramento and San Joaquin valleys and the South Coastal Valleys (2). Most of the land was in cereals and alfalfa, with only a small portion of it in orchards and gardens.

This was the period, too, of "irrigation colonies." Numerous settlements had already sprung up, at Riverside, Redlands, Pasadena, Pomona, and other southern California sites, while the Fresno area was a population center in the San Joaquin Valley. These "colonies" were usually not rigidly organized groupings, Some consisted of a few acquaintances; some were groups of people from certain localities in the eastern states and Europe; and still others were individual families brought together from everywhere by general advertising and promotional propaganda. The dominance of such groupings in the early history of irrigation in California, in contrast to the more individual undertakings of settlers in the humid lands of the United States, partly reflected the greater need for cooperation in the face of increasing environmental (that is, climatic) adversity (3). Even today, a major part of the irrigated area in California is under the administration of group organizations (irrigation districts).

Challenging the desert: 1880-1920. The progressive extension of the frontiers of irrigation farming into the drier portions of California during the period 1870 to 1880 was more than matched in succeeding decades. The San Joaquin Valley, as early as 1889, had almost half the state's irrigated acreage (Table 1). Second in importance at this date were the semiarid South Coastal Valleys, which, however, had not quite a third as much irrigated cropland as the San Joaquin Valley. The acreage in the Sacramento Valley, in turn, was exceeded by that in both these regions. The tardy growth of irrigation in the Sacramento Valley explains in part the increasing emphasis during this period on irrigation farming in the drier portions of California. Rainfall was relatively more plentiful in the Sacramento Valley, and therefore the valley did not require as much artificial watering. Areas of good soil in the semiarid and arid lands, especially in the San Joaquin Valley, are larger, because there is less leaching. And, perhaps most important, temperatures were higher in the more southerly valleys, thus speeding growth and making possible a greater and more varied agricultural production. Fruits, which require more water than field crops and thrive

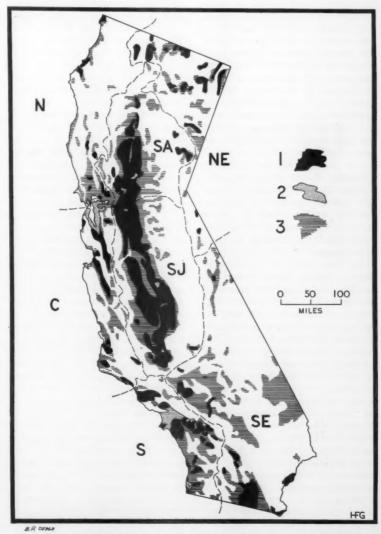


Fig. 2. Irrigation in California: (1) Irrigated land, (2) urban area, (3) irrigable land. Major lowland complexes: N, North Coastal Valleys; C, Central Coastal Valleys; S, South Coastal Valleys; SA, Sacramento Valley; SJ, San Joaquin Valley; NE, Northeast Interior Basins and Valleys; SE, Southeast Desert. [After L. R. Wohletz and E. E. Dolder, Know California's Land (State Printing Office, Sacramento, 1952) and Calif. State Water Resources Board Bull. 2]

better in the milder areas, were becoming an important part of California's production in the period 1880 to 1890. The direct connection of southern California with the East in 1881, by the Southern Pacific Railroad and the coming of railroad refrigeration in 1888 further stimulated agricultural production and thus the growth of irrigation, to the benefit of the southern half of the state.

The position of the Imperial Valley up to the turn of the century best illustrates an important agricultural problem in California: in the north, more moisture but less level land for cropping and a shorter growing season; in the south, more potential cropland and longer growing seasons but greater drought. Except for a narrow coastal strip in southern California, the areas where there are the longest periods between killing frosts are the Imperial Valley and other southerly portions of the Southeast Desert. This advantage is heightened by the higher temperatures of the interior. But this section is also the driest in California, and in the nation. An example is Brawley, an important marketing center in the Imperial Valley, which receives an average annual rainfall of just over 2 inches. Also, unlike the situation in either the Central Valley or coastal southern California, no major streams flow into the Southeast Desert from nearby mountains. Instead, the area is in the rain shadow of both the Sierra Nevada and the southern California coastal ranges.

But there remained the Colorado River to the east. The story of the tapping of the Colorado in 1901, via a canal that cut through over 80 miles of forbidding desert terrain, is now history, but the tremendous change in the irrigation status of the Southeast Desert is still manifest. From a position, in 1900, of inferiority, from the standpoint of acreage under irrigation, to every other major section of the California dry lands, it rose after World War II to equal, in acreage under irrigation, the South Coastal Valleys, and it seriously challenged the Sacramento Valley even earlier (Table 1). Prior to the irrigation of the Imperial Valley, most of the irrigated acreage had been in the northern and higher, or Mohave, portion of the Southeast Desert, where the growing season was not quite as long and the danger of winter frosts was greater.

Meanwhile, great additions were being made to the other principal irrigation areas of the state. Only in the Northeast Interior Basins and Valleys did expansion lag. The expansion in the Sacramento Valley was clearly evident by 1920 when this area surpassed the South Coastal Valleys in acreage under irrigation-this despite continuing impressive increases by the latter as well. The 1920 agricultural census also revealed moderately impressive growth in irrigation in the Central Coastal Valleys. Much of this land was formerly dryfarmed, but the better yields brought by irrigation, as well as by increasing the planting of tree crops, made big increases in irrigation farming inevitable. While the major growth of irrigation farming in the Southeast Desert during the early 1900's was in the Imperial Valley, other smaller oases were showing signs of development in this same period. Most important were the Antelope Valley (the westernmost extension of the Southeast Desert), the Mohave River Valley (east of the Antelope Valley), the Coachella Valley (north of the Imperial Valley), and two small sections along the Colorado River-the Palo Verde and Bard Valleys.

Advance and retreat: 1920-1954. The irrigation farming area has continued to grow in the Southeast Desert since the opening of the Imperial Valley. This increase becomes even more significant when compared with the situation in the South Coastal Valleys. Since World War II, the cropland area around Los Angeles has been slowly but steadily declining before the tremendous growth of the city and its numerous satellite urban centers. This marks the first time that modern irrigation farming in a major agricultural region of California has not registered an increase (Table 1). A partial result of this decline has been a further stimulus to cropland expansion in the immediately adjacent Southeast Desert region. The same situation has developed to a smaller degree in the San Francisco Bay Area conurbation; this has also resulted in increasing dependence on the oases (4).

An even weightier counterbalance to the acreage losses in coastal southern California was the remarkable advance in irrigation farming in the San Joaquin Valley, Between 1920 and 1954 the Sacramento and San Joaquin valleys gained a total of approximately 2.4 million acres of irrigated acreage-well over half again as much as the total irrigated area in the state in 1900. Three-fourths of this growth was in the drier west side of the San Joaquin Valley. Prior to even as late as the middle 1930's, most of the west side of the valley was termed a "desolate wasteland of jack-rabbits and sagebrush, with a limited amount of

grazing for cattle and sheep" (5). The well-developed portion of the valley, largely the eastern third, had access to the major streams of the Sierra Nevada. The greatest concentration of the good soils of the valley was also there. Here, then, were the early sites of agriculture in the San Joaquin Valley, and, in fact, this section remains the core of many of the agricultural industries in the valley today.

Lying next to the lower coastal ranges on the western side of the valley, where there are fewer and smaller streams, the west side was unable to support much intensive agriculture worthy of the name. All was not "desolate wasteland," however. In the northern and middle portions of this area, where both the amount and the effectiveness of precipitation are a little greater, dry grain farming was practiced (6). In the late 1920's the perfecting of the deep-well turbine pump, plus high farm prices, made it economically practicable, for the first time, to tap the deeper connate water supplies of the west side of the valley. But the greatest surge was to come after World War II, the same period in which irrigation acreage began to decline in the coastal lowlands of southern California. Western Fresno County was the center of this growth; there irrigated acreage rose phenomenally from 90,000 in 1945 to 520,000 in 1951 (7).

#### **Future Growth of Irrigation Farming**

Directional trends. The growth of irrigation agriculture in both the San Joaquin and Sacramento valleys appears assured for at least the near foreseeable future. Much of this expansion antedated the Central Valley project, which is only now just beginning to show its benefits in a major way. Much land also remains to be reclaimed, the only immediate principal obstacle being availability of water. It is hoped that the problem of the now falling water table in the San Joaquin Valley (especially on the west side) will not become critical before construction of the planned additional irrigation facilities in the Central Valley project is completed and proposals for the Feather River project mature. Certainly there appears to be no indication, either, of a halt in the rise in irrigation farming in the Southeast Desert. Extrapolations of the curve for population growth in coastal southern California indicate that there will be even greater losses of agricultural land in that area in the future. While yield intensities may



Fig. 3. Irrigated basin in the Mono Lake region. The sagebrush area in foreground is irrigable; the land on the lower grass slopes of the Sierra Nevada in the distance, just beyond irrigated flats, may be irrigable.

temporarily mask this increasing decline in the amount of irrigated cropland, the trend seems unmistakable: an increasing dependence on the desert for satisfaction of local and national food needs.

h

le

10

P's

it

te

er

Y.

er

ch

he

ia.

er

ge

45

ri-

oa-

as-

ble

ted

nly

fits

ins

ate

of

of

San

rest

on-

rri-

lley

for

Cer-

ion,

tion

rap-

tion

in-

ater

a in

may

. 129

Relatively unnoticed in the impressive showing of the Central Valley and the Southeast Desert during the last half century has been the surge of the Central Coastal Valleys. In 1954 this region had about equalled the South Coastal Valleys in area under irrigation. As in the case of the Southeast Desert region, such increases were greatly stimulated by the losses of agricultural land to urban use in both the San Francisco Bay and Los Angeles areas; but the Central Coastal Valleys do not appear to have as good a prospect as the Southeast Desert for continued expansion of irrigation farming, in part because of the more restrictive terrain, but more because of the far greater potentialities of the Central Coastal Valleys for urbanization. The region is situated between the two main metropolitan centers of the state and has the seeds of further urbanization within its own area in the several towns of the central California coast.

Two movements, therefore, characterize areal trends in California's irrigation farming: (i) an increasingly southerly shift, further emphasizing the dominance of central and southern California; (ii) an easterly shift, from the coast to the interior—so far not as impressive as the first trend in actual acreage involved but with perhaps much more significance for the future. In both cases, the movements have created increasing pressure on the drier lands of the state.

Urban and agricultural land pressures. The pressures on the dry lands are both agricultural and urban in nature. In coastal southern California, the rapidly growing metropolitan complex has been a major factor in augmenting the pressure on the adjacent desert and will undoubtedly continue to be one in the future. In no other portion of the Western Hemisphere does so large an urban center impinge on arid land margins. Although local environmental and economic variations complicate the picture, there is a rough areal sequence in type of land use between the Los Angeles urban core and the outer (northern and eastern) margins of southern California: immediately adjacent to the built-up area is the most intensive type of agriculture in the region, irrigation farming; next is an area with a more extensive type of cropping, dry farming; on the peripheries of the ecumene, cropping disappears and only a very extensive type of livestock raising (in some areas, not even this) is pursued. This sequence may be ascribed in some part to the effect of increasing transportation costs for agricultural products as the distance between the main urban market and outlying producing centers becomes greater. The increased cost of land as the city area is approached is an even more important cause of this progression. Higher land rents, a result more of urban than of agricultural demands, stimulate an increase in agricultural intensity. This increase in intensity is reflected, in semiarid and arid lands especially, by the introduction and expansion of irrigation.

As the urban center grows, the cir-

cumferential land-use areas tend to migrate in the same direction. Thus, while irrigated lands have retreated before rapidly growing Los Angeles, they in turn have expanded at the expense of dryfarming sections. This outward movement has been much less noticeable for the dry-farming areas, although their character is modified through the substitution of more intensively cultivable crops (for example, vegetables in place of grain) as the irrigated sections approach. Also, to be sure, another factor modifies somewhat this pattern of areal and temporal changes in land use types: the effect of out-of-state markets. Most of the initial expansion in irrigated citrus acreage in the Los Angeles area, for example, was due to demands of the Eastern states, not those of Los Angeles. Yet, present shifts in acreage devoted to citrus fruits and other specialty crops with national markets also indicate the effect of urban encroachment as high-priced orchard and vegetable land is abandoned to the growing metropolitan area and more distant and less intensively cultivated agricultural land is sought for new plantings. The more recent greatly increased demands of the Los Angeles market and their effect on land-use change in the "rural-urban fringe" should not be overlooked, either. The increase in requirements for fruits and vegetables of this market has further promoted the outward expansion of the more intensive irrigation farming at the cost of dry farming and other less intensive types of farming (8).

There thus exist, actually, not just one but several land-use pressures, each affecting the other, the total effect being an advance of agriculture into the unutilized dry regions. The trend toward development of a ringlike pattern of land-use types surrounding an urban core illustrates von Thünen's law of land-use intensity, stated well over a hundred years ago (9). This trend applies not only to the principal urban area of Los Angeles and to the surrounding agricultural area but also, on a smaller scale, to Los Angeles' numerous satellite cities and their environs within coastal southern California. Such items as irregular terrain, microvariations in climate, availability or nonavailability of water, and the economic "pull" of urban expansion along radial transportation routes make the actual picture a complex one. But, again, this does not basically alter the picture of an over-all tendency toward a concentric pattern of land use.

Figure 4 (right) is a schematic illustration of these patterns of varying land-

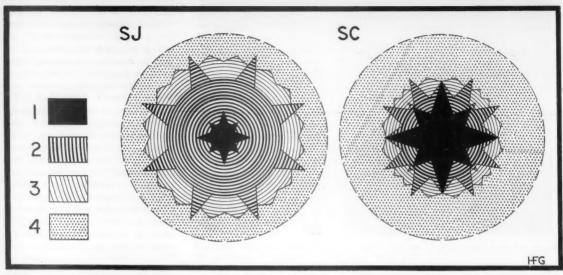


Fig. 4. Schematic diagram of spatial patterns of land-use pressure tendencies: (1) urban areas; (2) irrigation-farming areas; (3) dry-farming areas; (4) extensive livestock-raising areas (desert). SI, San Joaquin Valley; SC, Southern California.

use intensity in the light of such tendencies. The wedges indicating urban use indicate the attraction of communication lines, along which the city expands (10). The freeways have been especially effective in this regard in the Los Angeles and San Diego areas. The channeling effect of the numerous valleys of coastal southern California may also be noted in these pronglike extensions. In some areas, irrigation farming also shows this tendency to put forth lone radial extensions, often penetrating the more peripheral and drier zones where no dry farming can intervene between the irrigated land and the surrounding "raw land."

Irrigation agriculture also tends to parallel the above-mentioned urban prongs where rapid transportation routes to markets exist. The more recent gains in irrigation farming in the Southeast Desert region of southern California are not contiguous to the irrigated areas of the coastal lowlands to the west. However, a sizable portion of the post-World War II increase in agricultural production in the irrigated Imperial, Coachella, and Palo Verde valleys has been due to the same pressures that have brought about the changes in types, and in areal patterns, of land use in the Los Angeles area: increases in urban markets and the need for new cropland to substitute for that lost to urban encroachment (8).

Urban pressures on the California dry lands are much less forceful in the San Joaquin and Sacramento valleys. A schematic diagram (Fig. 4, left) similar to that drawn for southern California but based on conditions in the San Joaquin Valley shows that irrigation agriculture is not only the most extensive but the dominant land-use pressure in the valley. This is further evidence that the San Joaquin Valley is the leading center of agricultural production (Table 1). Dryfarming areas on the outer margins of the irrigated area are also larger in the San Joaquin Valley than they are in southern California, and they embrace considerable areas along most of the valley periphery (Figs. 2 and 5). But, as in the southern portion of the state, sizable wedges of irrigation farming occasionally invade the more truly arid areas where dry farming is impossible. Aridity is not the only factor that restricts dry farming, by the way. Undeveloped land in or near irrigation-project areas usually increases markedly in value. Thus, just as urban influences on land valuations tend ultimately to discourage agriculture, the impact of irrigation farming on land prices tends to encourage intensive agriculture.

According to recent estimates, the San Joaquin Valley has somewhat less land available for future irrigation than the Southeast Desert (Table 1 and Fig. 2). While the proportion of urban land and the rate of urban growth are much smaller than in southern California or the San Francisco Bay area, urbanism in the San Joaquin and Sacramento valleys should not be underestimated. Such cities as Sacramento, Stockton, Fresno, and

Bakersfield are still well ahead of the national growth average for centers of their size, and increasing loss of agricultural land on the city borders is a problem for them as well as for the two principal California metropolitan areas (11). However, the numerous advancing prongs of the Central Valley cities have had little effect on the outer margins of the irrigation-farming areas; this is quite in contrast to the situation in the southern California lowlands, where the ratio of urban area to cropland is noticeably greater.

That these tendencies toward peripheral expansion of both urban and agricultural lands will continue is fairly certain. And there is likewise little doubt that the land-use pressures on the dry lands in southern California will be increasingly attributable to urban growth, while advances on the arid sections of the San Joaquin Valley will remain largely agricultural in nature for some time to come. In southern California, for instance, the coastal urban mass has already, in some places, expanded into desert lands ahead of agriculture. These "suburbs in the sun" differ from the earlier settlements in the Southeast Desert in that, for establishment of the latter, a local agricultural base was considered an essential prerequisite (12). That there will be in the future a continuous urban area stretching from Los Angeles to San Diego and from the Pacific to the Los Angeles coastal ranges seems now a matter of certainty rather than merely an

overoptimistic prediction by southern Californians. A similar development is in prospect for the San Francisco Bay region, where several of the valleys ringing the bays are undergoing rapid urbanization.

#### **Availability of Water**

lrv-

the

of

cul-

ob-

rin-

11).

cing

ave

s of

uite

ith-

atio

ably

iph-

gri-

irly

oubt

dry

in-

wth,

s of

nain

ome

, for

al-

into

hese

the

Des-

tter,

ered here

rban

San

Los

mat-

an

.. 129

Certainly the tremendous expansion of population and cropland at the expense of the California dry lands would not have been possible without a plentiful supply of water. California shares with the Pacific Northwest, middle Chile, Peru, and northern India the good fortune of having its dry lands in close juxtaposition to a very humid watershed. This areal relationship in California appears even more intimate when viewed locally: While the Sacramento and San Joaquin valleys are, in general, fairly intensively irrigated today, it is on the eastern sides of both lowlands that irrigation is most widespread-the areas closest to the Sierra Nevada and its numerous streams. The South Coastal Valleys likewise have for a long time owed a major share of their ground-water supplies to the encircling ranges of southern California. The correlation between dry lowland and mountain watershed along the margins of the Southeast Desert is now less evident than it was before irrigation water was imported into the more interior Imperial and Coachella valleys. Yet the underground reservoirs of water along the eastern foot of the Sierra Nevada and the Los Angeles ranges, while limited, have supplied several locally important irrigation farming areas, the most important being the previously mentioned Antelope Valley.

Such a simple geographical relationship as this, however, masks several other considerations affecting the availability of water, some of which may be of even greater significance to the future expansion of irrigation farming than just physical availability. These other "availabilities" are principally four in number: economic, political, areal, and technological. In actuality, none of these can be considered alone in viewing the current water problems of any particular irrigation-farming area, and only a few examples of their significance can be noted here.

Economic and political availability. A common misconception about the California water problem is that the combination of agricultural, industrial, and domestic demands will eventually exceed the water reserves of the state. The latest engineering reports state that there is within the state water above and beyond the needs of a prospective population of 40 million and for a potential irrigated agricultural area twice as large as the present irrigated acreage (13). Yet, the distance between some of those watersheds which are as yet relatively untapped and the particularly water-deficient lowlands is great enough to make the matter of financing a serious obstacle, even in such a rich state as California. The best example of this difficulty to date has been the relationship between Los Angeles, the major center of capital in the state, and neighboring southern California cities in the region's attempt to obtain Colorado River water.

Prior to 1928, Los Angeles, with its larger supply of water, was able to expand and build up its financial reserves at a much greater rate than were the surrounding urban centers. This in turn enabled the city to obtain even greater supplies of water, culminating in construction of the major Owens Valley Aqueduct. The result of this spiral of expansion was the crippling of the growth of other cities and towns, many of which were forced to request annexation to Los Angeles rather than face water starvation, especially in times of prolonged drought.

Continued urban expansion forced Los Angeles to look next to the Colorado River, a project which was to be even more costly than the Owens aqueduct and which would require not only additional capital from other southern California cities but their political support as well. Capital and political support were even more critical for the smaller cities, of course. The result was the organization of the Metropolitan Water District of Southern California, in 1928, an organization that now includes almost all of the cities of southern California and that fosters new water developments but allows these cities new freedom in their individual development (14). Thus, a further stimulus to urban expansion in southern California was provided -a movement which, as noted before, has encouraged the expansion and outward migration of irrigation farming on the urban margins.

The fact that most major water projects in California in the last 25 yearswith the exception of the Central Valley project-have been initiated by, and constructed for use by, urban areas emphasizes the new and growing financial and political problems that stem from the problem of availability of water: the conflict between the water demands of agricultural and urban users. Although about 90 percent of the water used in California is used for irrigation, a major part of the capital needed for future water projects is controlled by urban interests. And this financial control is obviously increasing, at a time when the contemplated costs of such projects are at levels never before attained. Combined with capital control is the growing political power of the urban areas.

The proposed Feather River project is the best example to date of the effect of this growing twofold dominance. A



Fig. 5. Dry-farmed grain on the eastern margin of the middle San Joaquin Valley with Sierra Nevada foothills in the background.

major obstacle so far has been the refusal of the Metropolitan Water District of Southern California to agree to the plan until a firm guarantee of a permanent supply of water is made to southern California. The Central Valley proponents of the project, especially those from the San Joaquin Valley, have protested against this delay, since the falling water table is of much more immediate concern to the farmers of the valley than to the urban populations of southern California, which currently receive adequate water from the Owens-Mono and Colorado aqueducts. A similar delay has been encountered in the legislature for the past two years. Thus, although 60 percent of the water of the Feather River project would go to the dominantly agricultural Central Valley, the actual construction still rests on the consent of financially more powerful urban southern California. Here again are reflected the urban pressures on the expanding irrigation-farming frontier in southern California, which may be contrasted to the more purely agricultural character of the pressures on the irrigation frontier in the Central Valley. The advancing margin of irrigated lands in the Southeast Desert region, in fact, might well be labelled a "frontier of substitution"that is, expansion on the desert periphery to compensate for losses in coastal southern California.

Indirectly related to the problem of

Fig. 6. Leveling of "raw land" in the Buena Vista Lake area, western San Joaquin Valley, prior to irrigation.



Fig. 7. Natural pasture on a sloping fan surface in the southwestern corner of the San Joaquin Valley, with apex of fan and coastal ranges in the background.

economic availability of water is the problem of sufficiency of markets for the products of California's irrigation farming. There has been much argument in the past over the raising of crops in western irrigated areas which compete with similar crops raised in the humid East at much less cost. The California dry lands fortunately lie largely in areas of subtropical climate which permits cultivation of many crops which are normally lacking in the East, either during the more rigorous winters or throughout the year. There is, in addition, the rapidly growing population of both California and the nation, as well as the high level of prosperity, to create new food demands

Areal availability. If it is assumed that water is economically available for all irrigable areas in California, the areal extent of those lands may be considered to be the ultimate determinant of how far the irrigation-farming frontiers shall advance. California has a sizable amount of both irrigated and irrigable land. It has long led the other states in expansion of irrigated land and contained, in 1954, better than one-third of the total irrigated land in the 11 western states in which most of the American dry lands are located (15). Its proportion of the national irrigated acreage is only slightly less impressive-24 percent.

The truly arid regions of Californiathe San Joaquin Valley and the Southeast Desert regions-together contained approximately 20 percent of the total irrigated area in the period 1949-1954. The San Joaquin has easily led all other single areas in the United States in advancement of irrigation farming into dryland margins (Fig. 6). Well over 2 million acres had already been irrigated by the time the Central Valley project was first beginning to show results and even before the west side expansion had started. The latter, incidentally, represents the largest single block of acreage to be put under irrigation in the United States since World War II, 1.2 million acres (16).

The statistics for irrigable area are even more encouraging. Sixty percent of the 17 million acres in the West which are capable of being irrigated lie within the boundaries of California. This amount is fairly well distributed among the principal irrigation-farming areas of the state. But it is again the San Joaquin Valley and the Southeast Desert which are the most favored (Fig. 7). The two regions include over 6 million (60 percent) of the total 10,837,600 acres of irrigable land (Table 1).

Qualifying this simple comparison of irrigated and irrigable land is the fact that a great proportion of the latter is of poorer agricultural quality than the former. It was natural that much of the best California soil would be utilized for irrigation farming first. Many of the best soil regions were directly in the paths of the early settlers (for example, the Los Angeles and Sacramento-Stockton areas); many were also supplied with surface water which was considered adequate for early irrigation-farming demands (for example, Los Angeles and the eastern San Joaquin Valley.

he

he

m.

in

in

id

nia

eas

ulor-

ng

out

p-

or-

gh

od

nat

all

eal

ed

ow

int

It

ion

54.

rri-

in

ads

the

tly

th-

ned

tal

54.

her

ad-

rv-

nil-

by

ven nad

re-

age

ted ion

are t of

ich

hin his

ong

s of

uin

ich

two

er-

of

129

Since the western side of the San Joaquin Valley and several sections of the Southeast Desert region are today, from the standpoint of size, the areas where advances in irrigation are most likely to be made, it is interesting to note that some of the most serious soil problems that will be encountered in future attempts at irrigation farming are concentrated in these regions. This is especially the case in the Southeast Desert, where the extremely sandy soil and low water table are expected to exact a much greater toll in water than is the case in plots of comparable size in other agricultural areas of the state.

A further handicap is the widely dispersed and fragmented distribution of the best soil areas, which makes it economically infeasible to irrigate many sections. In consequence, the Southeast Desert has by no means the advantage over the drier portions of the San Joaquin and Sacramento valleys that comparative figures for acreage of irrigable lands indicate (Table 1). It is a reclamation tragedy of the first order that the Southeast Desert, which has the largest amount of land available for irrigation of any area in California, as well as one of the longest growing seasons, has more potential irrigation problems, exclusive of the problem of water supply, than any other area (17) (Fig. 8).

Better quality of soil, as well as larger supplies of water, make the west side of the San Joaquin Valley a decidedly better risk than the Southeast Desert. As noted before, this is the most important area of expanding irrigation in California at present. But, in comparison with the problems of the east side of the San Joaquin Valley, the problems which make the west side still a pioneer region stand out. Most of the great agricultural expansion in the drier western two-thirds of the valley has been in field crops. In contrast are the more numerous orchards and vineyards of the better developed east side; such crops are generally more

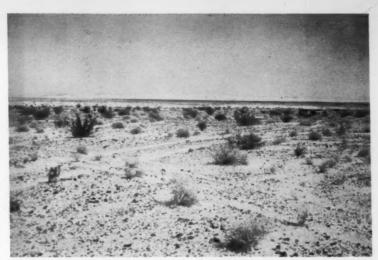


Fig. 8. "Raw land" of West Mesa area in the Southeast Desert, on the western side of the Imperial Valley. Extensive sand dunes may be seen on the horizon.

valuable than barley, wheat, and flax, which, with cotton, are the principal rotation crops. While cotton is currently the most profitable crop in the San Joaquin Valley, it is the lack of more intensive rotation partners which largely prevents the west side of the valley from attaining the agricultural maturity of the eastern half. An important factor in this difference in crop emphasis is the high boron content of the soil and water of the west side. More fruit plantings are now being made, and while yields seem to compare favorably on the whole with those of the older fruit lands of the San

Joaquin, the quality is not exceptional.

The poorer soil quality and smaller water supply of the west side of the San Joaquin Valley and the Southeast Desert, with their large areas of irrigable lands, have made these regions areas of large farms as well. The average farm on the west side of the San Joaquin Valley is about 4000 acres, while in Imperial County, the largest single concentration of farms in the Southeast Desert region, over half of the units are 1000 acres or larger. Although it is generally agreed that the prevalence of large landholdings materially retarded early irrigation de-



Fig. 9. "Mound" terrain in the drier west side of the Sacramento Valley. The chances of damage to the soil profile are great if ditch irrigation, with prior leveling, should be introduced.



Fig. 10. Hill lands on the western margin of the Sacramento Valley, where sprinkler irrigation appears to give promise of good results. The irrigated valley floor appears in the foreground, and peaks of the coastal ranges may be seen beyond the hills.

velopment of such areas as the San Joaquin and Sacramento valleys, it is quite doubtful that the drier areas like the west side of the San Joaquin Valley could have been irrigated much earlier, especially without causing great losses in income. In fact, several large landowners (and very often land companies) suffered financial reverses in attempting irrigation reclamation as early as the late 1800's in the drier portions of the San Joaquin Valley.

General farming practices on the typical west-side farm today, make mandatory a minimum of 1000 acres for economic operation. Water must be pumped from average depths of 400 to 450 feet,

But even an annual pumping bill of \$7500 for a section of land is exceeded by the costs of both cotton picking and fertilizers. To realize on the investment in pumping equipment, irrigation must be continued almost throughout the year. This, in turn, requires a greatly enlarged cropping acreage in the winter to compensate for reduced irrigation demands during that season. Moreover, an average of a quarter to a third of the farm is kept in fallow. This reduces the demands for water somewhat and is believed to be a help in reducing the harmful effects of boron. Increasing costs, due to recurrent investment in more and newer farm equipment, further contribute, as in other areas of the United States, to the growing economic need for larger farms. Land-leveling and soil-conditioning operations will add considerably more to future reclamation costs and perhaps even slow the over-all advance of irrigation farming. So far, much of the newly irrigated land of the San Joaquin Valley has been converted pasture and dry-farmed land, whereas an increasing amount of "raw land" will have to be conquered in the future. The operator of a large farm faces even greater difficulties in the Southeast Desert, where water and soil restrictions are so severe that a sizable portion of the region is now under Bureau of Reclamation withdrawal regulations.

Technological Availability. While such farming procedures as deep-well pumping, large-scale use of machinery, land leveling, and soil fertilization have increased costs for the irrigation farmer, they have also made for great benefits. Improved irrigation techniques have made water available to larger and larger areas, as well as in greater amounts. Improved methods for use of water have also been promoted. The result has been impressive gains, both in acreage and in yield, in agricultural production.

If, as is maintained by Webb, the windmill and barbed wire deserve much credit for the agricultural opening of the Great Plains (18), then certainly the pump and, more recently, the sprinkler can be said to have played similar roles in the progress of irrigation farming in the California dry lands. Though the first irrigation developments utilized surface water, it was not until the underground supplies were used extensively that irrigation farming began to expand in a major way, notably in the San Joaquin Valley and the South Coastal Valleys. Also, it was the deep-well turbine pump which made it economically possible to lift water from great depths, thereby paving the way for the first great development in irrigation cultivation in the west side of the San Joaquin Valley.

Sprinkler irrigation systems, first developed in the East over 50 years ago, have become especially popular since World War II with the introduction of improvements such as quick coupling and aluminum tubing. Sprinklers are more efficient than furrows, and, by increasing the permissible slope limit for irrigated tree farming to around 30 percent, have made possible the utilization of terrain formerly considered too rough for successful agricultural development (Figs. 9 and 10). Comparison of 1939 and 1955 estimates of the amount of land

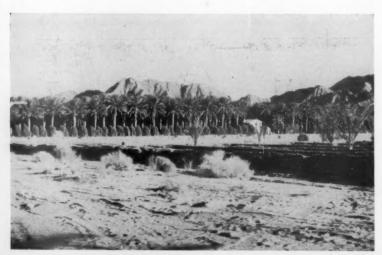


Fig. 11. Date groves on a sloping alluvial fan surface in the Coachella Valley, with more recent plantings in the right foreground.

that will ultimately be irrigated shows, for the Central Valley alone, an increase, based primarily on this consideration, of approximately 1.4 million acres (19), Land leveling, an absolute requirement for ditch irrigation, is not as vital if sprinklers are used. This fact has been of especial benefit in the western San Joaquin Valley, where well-developed soil profiles can often be irreparably damaged by even the most judicious leveling-quite a different situation from that in the Southeast Desert, where soils are younger. Sprinkler irrigation systems also offer the possibility of making financially feasible the irrigation of some of the small, dispersed plots of irrigable soil, as in the Southeast Desert. Sprinkler irrigation is thus one of the best examples of a situation where increasing technological development (when it occurs in conjunction with good markets) instead of relieving pressure on undeveloped agricultural lands actually in-

ited

for

con-

der-

costs

r-all

far,

the

rted

reas

will

The

ven

Des-

are

the

ma.

uch

np-

and

in-

ier.

fits.

ave

ger

m-

ave een

in

the

ich

the

the

ler

les

in

he

ir-

er-

ely

nd

a-

al-

ne

-20

ıs,

at

in

V.

e-

of

re

or

r-

n

h

ıt

9 d

n- .

But sprinklers are not a panacea. While initial installation costs are low compared with those of a fixed system of irrigation, continuing overhead charges are higher. Soils with very low waterabsorption rates can often be better watered by the furrow method. Where soils are too permeable, longer sprinklings will cause loss through deep percolation. Evaporation rates are also quite high. In addition, sprinkling is most effective only at prescribed pressures (20).

The utility of water has been enhanced even further by numerous other technological improvements. Crop yields have been greatly boosted by such advances as more and better machinery, greater use of fertilizers, better soil conservation practices, improved varieties of plants, improved strains of animals, and improvements in production, processing and marketing methods. California now maintains a commanding lead among the states in expenditures for machinery and fertilizer. Increases in yield have noticeably delayed the full impact of the diminution in acreage devoted to agriculture on farm production in rapidly urbanizing areas. A case in point is that of the South Coastal Valleys region, which, since 1945, has lost more agricultural land to urban and industrial uses than any other section of the state but, at the same time, has led all other areas in the expansion of agricultural production for local needs. Almost 70 percent of the fresh fruit and vegetable supplies for the two great urban centers of California still comes from the imme-

diate coastal area, where urbanization of agricultural land has been most extensive.

Importation of water, made possible through an extensive and complicated system of canals, pipelines, dams, and pumping stations, is promising to be, for irrigation in California, what it has been for the Los Angeles and San Francisco Bay urban areas. This is again especially true for the drier areas; the Imperial and Coachella valleys are now supplied by the Colorado River, and the southern and western margins of the San Joaquin Valley are getting increasingly large quantities of water from the Central Valley project as it nears completion (Fig. 11). The Feather River project promises to irrigate even more of the Central Valley, as well as portions of the western margins of the Southeast Desert.

But the project also points up the increasing costs of water so obtained, to which the agricultural economy is much more sensitive than the urban. Greater need and higher water charges will result in the diversion to urban use of most of the Feather River water to be made available for the South Coastal Valleys, although this may in turn release to farm lands some additional Colorado River water now being reserved for future urban requirements.

Current costs of sea-water reclamation make the use of sea water for irrigation farming even less likely. Although there has been much recent publicity about impending success in efforts to demineralize water at prices that would make this process economically feasible, it should be remembered that "economically feasible" means at prices which only industrial and urban users seem able to bear. Also hindering any extensive use of reclaimed sea water would be the costs of the pumping equipment necessary to get the water over the coastal ranges to the San Joaquin Valley and the Southeast Desert. Extensive use of atomic power for pumping is still in the theoretical stage. Yet, extensive use of reclaimed sea water by the cities would undoubtedly release an abundant supply of Colorado River and Sierra Nevada water, now consumed to a large degree by the cities, to the agricultural regions.

Desalinization of brackish water offers some hope for increasing the water supply for irrigation farming. The salt content of such water is, on the average, only about one-tenth that of sea water. Since brackish waters are common in both the San Joaquin and the Imperial

valleys, importation (that is, pumping) costs would also be considerably lower than those incurred in any scheme for recovery of sea water. A more currently realizable water reclamation plan appears to be that of sewage reclamation. Cost estimates show that charges for such water would be only about onesixth of the charges for reclaimed sea water. A small element of health hazard would still exist, however, if sewage water were improperly treated.

#### References and Notes

- 1. C. W. Thornthwaite, Geograph. Rev. 38, 55 (1948)
- F. W. Roeding ["Irrigation in California," U.S. Dept. Agr. Bull. 237 (1911), p. 34] quoting the report of the state engineer.
- ing the report of the state engineer.

  See K. A. Wittfogel's expansion of this thesis in "The hydraulic civilizations," in Man's Role in Changing the Face of the Earth, W. L. Thomas, Jr., Ed. (Univ. of Chicago Press, 1956), pt. 1, pp. 152-164.

  H. F. Gregor, "The geographic dynamism of California market gardening," Yearbook Assoc. Pacific Coast Geographers No. 18 (1956),
- 5. G. McNulty, Calif. Cultivator 93, 417 (1946).
- S. N. Dicken, Econ. Geography 8, 97 (1932).
   C. Cole, "The Fresno area." Transcontinental Excursion Guidebook 17th Intern. Geograph. Congr., Washington, D.C. (1952), p. 218.
- Congr., Washington, D.C. (1952), p. 218.
  The increase in irrigation-farming production around San Diego as a result of Los Angeles' increased demands is a very good example of this point. H. F. Gregor, Ann. Assoc. Am. Geographers 47, 271 (1957).
- J. H. von Thünen, Der isolierte Staat in Beziehung auf Landwirtschaft und Nationalökonomie (Jena, Germany, 1826).
- 10. For a fuller statement of the "wedge theory" of urban growth, see R. M. Hurd, Principles of City Land Values (Record and Guide, New York, ed. 2, 1924) and H. Hoyt, "The structure and growth of residential neighborhoods in American cities," Federal Housing Admin. Publ. (1939).
- 11. H. F. Gregor, Land Economics 33, 316 (1957). R. F. Logan, Ann. Assoc. Am. Geographers 46, 259 (1956), abstr. Such suburban develop-
- 46, 259 (1956), abstr. Such suburban developments in nonagricultural areas are interesting exemplifications of the thesis of L. Koenig ["The economics of water sources," in The Future of Arid Lands, G. F. White, Ed. (Am. Assoc. Advance. Sci., Washington, D.C., 1956), pp. 320–328] that initial urban rather than agricultural utilization of dry lands is a more efficient type of land use.

  S. Parabean Jr. These Water loss California.
- 13. S. Brubaker, Is There Water for California?

  (Bank of America, San Francisco, Calif., 1955), p. 6, Many of the data used in this monograph were obtained from preliminary statistics which appeared in "Water utilization and requirements of California," Calif. State Water Recenters Found Bull 2 (1985) Water Resources Board Bull. 2 (1955).
- Water Resources Board Bull. 2 (1955).

  14. The Los Angeles expansion policy is treated fully in V. Ostrom, Water and Politics: A Study of Water Policies and Administration in the Development of Los Angeles (Haynes Foundation, Los Angeles, Calif., 1953).

  15. C. O. McCorkie, "A statistical picture of California's agriculture," Calif. Agr. Expt. Sta. Circ. 459 (1957), p. 6.

  16. H. H. Wooten and M. R. Purcell, "Farm land development: present and future," U.S. Dept. Agr. Circ. 825 (1949), p. 52.

  17. See, for example, the problems listed by R.

- See, for example, the problems listed by R. M. Glendinning for the Coachella Valley [Geograph. Rev. 39, 228 (1949)].
- 18. W. P. Webb, The Great Plains (Ginn, Boston, 1931).
- 19. P. Meigs III, Geograph. Rev. 29, 252 (1939); "Water utilization and requirements of California," in Calif. State Water Resources Board Bull. 2 (1955), vol. 1.
- F. J. Vichmeyer, "Sprinkling for irrigation," Calif. Agr. Exptl. Sta. Circ. 388 (1948), pp. 14-15.

### Chemistry of Insulin

Determination of the structure of insulin opens the way to greater understanding of life processes.

F. Sanger

In 1943 the basic principles of protein chemistry were firmly established. It was known that all proteins were built up from amino acid residues bound together by peptide bonds to form long polypeptide chains. Twenty different amino acids are found in most mammalian proteins, and by analytical procedures it was possible to say with reasonable accuracy how many residues of each one was present in a given protein. Practically nothing, however, was known about the relative order in which these residues were arranged in the molecules. This order seemed to be of particular importance since proteins, although they all contained approximately the same amino acids, differed markedly in both physical and biological properties. It was thus concluded that these differences were dependent on the different arrangement of the amino acid residues in the molecules. Although very little was known about amino acid sequence, there was much speculation in this field. The most widely discussed theory was that of Bergmann and Niemann, who suggested that the amino acids were arranged in a periodic fashion, the residues of one type of amino acid occurring at regular intervals along the chain. At the other extreme there were those who suggested that a pure protein was not a chemical individual in the classical sense but consisted of a random mixture of similar individuals.

Due largely to the work of Chibnall and his colleagues (I), insulin had been studied in considerable detail. It had a somewhat simpler composition than most proteins in that two of the commonly occurring amino acids, tryptophan and methionine, were absent and an accurate

analysis was available. Moreover, using the van Slyke procedure, Chibnall had shown that insulin was peculiar in having a high content of free α-amino groups. This indicated that it was composed of relatively short polypeptide chains, since free a-amino groups would be found only on those residues (the N-terminal residues) which were present at one end of a chain. Thus, the number of chains could be determined from the number of these N-terminal residues. The nature of one of these N-terminal residues was in fact known. Jensen and Evans (2) had shown that the phenylhydantoin of phenylalanine could be isolated from an acid hydrolyzate of insulin that had been treated with phenyl isocyanate, thus indicating that phenylalanine was at the end of one of the chains. At that time this was the only case where the position of an amino acid in a protein was known.

There was considerable doubt about the actual molecular weight of insulin and hence about the number of amino acid residues present. Values varying from 36,000 to 48,000 derived by physical methods had been reported, but it was shown by Gutfreund (3) that these high values were due to aggregation, and it was suggested that the real molecular weight or subunit was 12,000. This indicated that there were about 100 residues in the molecule. More recently, Harfenist and Craig (4) have shown that the actual value is about 6000; however, during most of our work it was believed to be 12,000.

#### Dinitrophenyl Method

In order to study in more detail the free amino groups of insulin and other proteins, a general method for labeling them was worked out (5). This was the dinitrophenyl (or DNP) method. The reagent used was 1,2,4-fluorodinitroben-

zene (FDNB), which reacts with the free amino groups of a protein or peptide to form a DNP derivative.

F 
$$NH_2 \cdot CH \cdot CO \sim$$

NO<sub>2</sub> + R

NO<sub>3</sub> Protein

R

NH · CH · CO

NO<sub>3</sub> + HF

NO<sub>2</sub> Protein

The reaction takes place under mildly alkaline conditions which normally do not cause any breakage of the peptide bonds.

The DNP-protein is then subjected to hydrolysis with acid which splits the peptide bonds in the chain, leaving the N-terminal residue in the form of its DNP-derivative.

The DNP-amino acids are bright yellow substances and can be separated from the unsubstituted amino acids by extraction with ether. They could be fractionated by partition chromatography, a method which had just been introduced by Gordon, Martin, and Synge (6) at that time. The DNP-amino acids could then be identified by comparison of their chromatographic rates with those of synthetic DNP-derivatives, In the original work on insulin, silica gel chromatography was used, though more recently other systems, particularly paper chromatography, have been found more satisfactory. When the DNP derivatives had been separated and identified they could be estimated colorimetri-

When the method was applied to in-

The author is a member of the Medical Research Council, working at the department of biochemistry of Cambridge University, Cambridge, England. This article is the lecture which he delivered in Stockholm, Sweden, on 10 Dec. 1958, when he was awarded the Nobel Prize in chemistry. The lecture is published with the permission of the Nobel Foundation.

Table 1. Results of partial acid hydrolysis of the DNP derivative of fraction B. The yield from DNP insulin is expressed in moles of peptide as a percentage of the total N-terminal phenylalanine residues of insulin.

Peptide	Products of complete hydrolysis of peptide	Products of partial hydrolysis	Structure	Yield from DNP insu- lin
B1	DNP-phenylalanine		DNP-Phe	13
B2	DNP-phenylalanine, valine	B1	DNP-Phe-Val	16
В3	DNP-phenylalanine, valine, aspartic acid	B1, B2	DNP-Phe-Val-Asp	13
B4	DNP-phenylalanine, valine, aspartic acid, glutamic acid	B1, B2, B3	DNP-Phe-Val-Asp-Glu	30
Other bands giving B4 on partial hydrolysis		-, -, -		20
Total				92

sulin, three yellow DNP-derivatives were found in the hydrolyzate of the DNP-insulin. One of these was not extracted into ether; this was 8-DNP-lysine, which was formed by reaction of the FDNB with the free e-amino group of lysine residues which are bound normally within the polypeptide chain. The others were identified as DNP-phenylalanine and DNP-glycine, and estimation on the basis of an assumed molecular weight of 12,000 showed that there were two residues of each. This suggested to us that insulin was composed of four polypeptide chains, two with phenylalanine and two with glycine end groups. This method has now been applied widely to many proteins and peptides and, together with the Edman phenylisothiocyanate method, is the standard method for studying N-terminal residues. In general it has been found that the chains of other proteins are much longer than those of insulin. All pure proteins appear to have only one or two N-terminal residues.

#### Separating the Peptide Chains

It seemed probable that the chains of insulin were joined together by the disulfide bridges of cystine residues. Insulin is relatively rich in cystine, and this was the only type of cross linkage that was definitely known to occur in proteins. It was thus next attempted to separate the peptide chains by splitting the disulfide bridges. Earlier attempts to do this by reduction to —SH derivatives had not proved successful and had given rise to insoluble products which were probably the result of some type of polymerization. More satisfactory results were

obtained by oxidation with performic acid (7). The cystine residues were converted to cysteic acid residues, and thus the cross links were broken.

Performic acid also reacts with residues of methionine and tryptophan, the two amino acids which fortunately were absent from insulin.

From the oxidized insulin two fractions could be separated by precipitation methods. One (fraction A) contained glycine; the other (fraction B), phenylalanine N-terminal residues. Fraction A was acidic and had a simpler composition than insulin in that the six amino acids lysine, arginine, histidine, phenylalanine, threonine, and proline were absent from it. It thus had no basic amino acids; these were found only in fraction B. From a quantitative determination of the end groups it was concluded that fraction A contained about 20 residues per chain, four of these being cysteic acid, and that fraction B had 30 residues, two of which were cysteic acid. Since the yield of each fraction was greater than 50 percent in terms of the N-terminal residues present and since the fractions appeared to be homogeneous, it seemed likely that there was only one type of glycyl chain and one type of phenylalanyl chain. This was confirmed by a study of the N-terminal sequences (8).

#### Results of Acid Hydrolysis

When the DNP derivative of fraction B was subjected to complete acid hydrolysis, DNP-phenylalanine was produced. If, however, it was subjected to a milder acid treatment so that only a fraction of the peptide bonds were split, DNP-phenylalanine peptides were produced which contained the amino acid residues near to the N-terminal end, and by an analysis of these peptides it was possible to determine the N-terminal sequence to four or five residues along the chain. The results for fraction B are shown in Table 1. It was concluded from these results that all the N-terminal phenylalanine residues of insulin were present in the sequence

#### Phe-Val-Asp-Glu

This suggested that if there were in fact two phenylalanyl chains, then these two were identical. Similar results were obtained with fraction A, and it was shown that the N-terminal glycine residues were present in the sequence

#### Gly-Ileu-Val-Glu-Glu

These results, besides giving information about the position of certain residues in the polypeptide chains, showed for the first time that the molecule was composed of only two types of chains and that if the molecular weight were 12,000, as was then believed, then the molecule was built up of two identical halves. The alternative conclusion was that the actual molecular weight was 6000, and this was later shown to be the case. At any rate the structural problem was somewhat simplified, since we were now concerned with determining the sequence in two chains containing 20 and 30 residues, respectively.

The main technical problem was the fractionation of the extremely complex mixtures that resulted from partial hydrolysis of a protein. However, Consden, Gordon, Martin and Synge (9) had shown that small peptides could be well fractionated by paper chromatography and had determined the sequence in the pentapeptide gramicidin S from the composition of peptides produced on acid hydrolysis.

At this point (1949) I was joined by Hans Tuppy, who came to work in Cambridge for a year. Although we did not seriously envisage the possibility of being able to determine the whole sequence of one of the chains within a year, we considered it worth while to investigate the small peptides from an acid hydrolyzate, using essentially the methods that had

been applied to gramicidin S. Studies were initiated on both the chains, at the same time, but it soon became clear that there would be more difficulties with fraction A, although it was the shorter chain, and the work on fraction B progressed so favorably and Tuppy worked so hard that by the end of the year we were virtually able to deduce the whole of the sequence of its 30 residues (10).

#### Sequences of Fraction B

Fraction B was subjected to partial hydrolysis with acid. Since the mixture was too complex for direct analysis by paper chromatography it was necessary to carry out certain preliminary group separations in order to obtain fractions containing five to 20 peptides that could then be separated on paper. This was accomplished by ionophoresis, ion exchange chromatography, and adsorption on charcoal. These simplified mixtures were then fractionated by two-dimensional paper chromatography. The peptide spots were cut out, and the material was eluted from the paper, subjected to complete hydrolysis, and analyzed for its constituent amino acids. Another sample of the peptide was then investigated by means of the DNP technique to determine the N-terminal residue. Table 2 illustrates the results obtained with a very acidic fraction obtained by ion-exchange chromatography. This contained only peptides of cysteic acid. Since there are only two such residues in fraction B, all these peptides must fit into two sequences. The way in which the two sequences

Leu-CySO<sub>2</sub>H-Gly

and

#### Leu-Val-CySO<sub>3</sub>H-Gly

were deduced from the results obtained with the peptides is illustrated in the table.

In this way about 45 peptides were identified in various fractions of the partial acid hydrolyzate, and the following five sequences were deduced as being present in the phenylalanine chain:

Phe-Val-Asp-Glu-His-Leu-	
CySO <sub>8</sub> H-Gly (N-terminal sequence)	(1)
Gly-Glu-Arg-Gly	(2)
Thr-Pro-Lys-Ala	(3)
Tyr-Leu-Val-CySO <sub>2</sub> H-Gly	(4)
Ser-His-Leu-Val-Glu-Ala	(5)

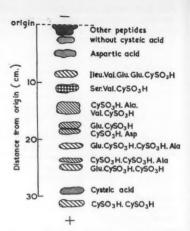
These five sequences contain all but four of the amino acid residues of fraction B. It was not possible to determine from the small peptides derived from acid hydrolyzates the position of the remaining four residues or the manner in which the five sequences given above were joined together. There were two reasons for this. First, there was considerable technical difficulty involved in fractionating the peptides containing two or more of the nonpolar residues such as tyrosine or leucine. It happened that these residues were grouped together in the chain (see below) and gave rise to a mixture of peptides that moved fast on paper chromatograms and were not well resolved. The second difficulty was due to the great lability in the presence of acid of the bonds involving the amino groups of the serine and threonine residue. It was never possible to find a peptide containing this bond and hence to know what residues preceded the serine and threonine

It was thus necessary to use another hydrolytic agent that would differ in specificity from concentrated acid. Hydrolyzates prepared by the action of dilute acid at high temperatures or of alkali were studied but yielded little further information. Much more successful. however, was the use of proteolytic enzymes (11). Initially we had refrained from using them, since it was considered that they might bring about rearrangement of the peptide bonds by transpeptidation or by actual reversal of hydrolysis. Subsequent work has, however, showed that this is not a very serious danger and that in fact proteolytic enzymes are the most useful hydrolytic agent for studies of amino acid sequences.

Proteolytic enzymes are much more specific than is acid, since only a few of the peptide bonds are susceptible. They give rise to larger peptides, which in general are more difficult to fractionate by paper chromatography. However, there are relatively few of them, so the mixtures are less complex. In this initial work we used essentially the same methods for studying the enzymic peptides that we had used for the acid ones, depending largely on paper chromatography for fractionation, although more recently it has been shown that better separations can be obtained by ion-exchange chromatography and by ionophoresis.

As an example we may consider a peptide Bp3 obtained by the action of pepsin. It had the following composition:

Phe (CySO<sub>8</sub>H, Asp, Glu, Ser, Gly, Val, Leu, His)



h

Fig. 1. Ionophoresis of partial acid hydrolyzate of fraction A at pH 3.5, showing separation of cysteic acid peptides.

Of these components the most important are aspartic acid and serine, since they occur only once in the chain. Aspartic acid is present only in the N-terminal sequence (1), and serine is in sequence 5. This shows that all of sequence 1 and at least the N-terminal part of sequence 5 are present in peptide Bp3. That none of the other sequences are present follows from the fact that Bp3 contains no arginine (sequence 2); threonine, proline, or lysine (sequence 3); or tyrosine (sequence 4). One may thus conclude that the two sequences are joined together. By studying other peptides obtained by the action of pepsin, trypsin, and chymotrypsin, it was possible to find out how the various sequences were arranged and to deduce the complete sequence of the phenylalanyl chain, which is shown below:

Phe-Val-Asp-Glu-His-Leu-CySO₃H-Gly-Ser-His-Leu-Val-Glu-Ala-Leu-Tyr-Leu-Val-CySO₃H-Gly-Glu-Arg-Gly-Phe-Phe-Tyr-Thr-Pro-Lys-Ala

In this work many more peptides were

Table 2. Cysteic acid peptides identified in a partial acid hydrolyzate of fraction B. The inclusion of residues in parentheses indicates that their relative order is not known.

Peptide	Peptide	
CySO <sub>8</sub> H-Gly	CySO <sub>a</sub> H-Gly	
Val-CySO <sub>3</sub> H	Leu-CySO <sub>o</sub> H	
Val-(CySO <sub>8</sub> H, Gly)		
Leu-(Val, CySO <sub>8</sub> H)	Leu-(CySO <sub>3</sub> H, Gly)	
Leu-(Val, CySO <sub>3</sub> H, Gly)		
Sequences d Leu-Val-CySO <sub>a</sub> H-Gly	educed Leu-CySO <sub>o</sub> H-Gly	

studied from both acid and enzymic hydrolyzates than were actually necessary to deduce the sequence. This was considered essential since the methods used were new and were qualitative rather than quantitative. The fact that all the peptides fitted into the unique sequence given above added further proof of its validity.

#### Sequence of Fraction A

hy-

ing

ant

nev

rtic

nal

nce

and

nce

one

fol-

no

oro-

sine

ude

to-

ob-

sin.

find

ar-

se-

nich

Leu-

Arg-

-Ala

vere

ed in

n B.

neses

not

y

Gly)

L. 129

Essentially similar methods were used to determine the sequence of fraction A (12). Although it was the shorter of the two chains, the determination of its structure was more difficult. Fraction B contains several residues that occur only once in the molecule, and this helps considerably in interpreting the results, whereas fraction A has only a few such residues, and these are all near one end. Also, fraction A is much less susceptible to enzymic hydrolysis. It is not attacked by trypsin, and there is a sequence of 13 residues which is not split by chymotrypsin or by pepsin, either. Considerable difficulty was at first experienced with the cysteic acid peptides. Fraction A contains the sequence

#### CySO<sub>8</sub>H-CySO<sub>8</sub>H

and this gave rise to a number of peptides which were very soluble in water and which would not fractionate easily by paper chromatography. However, it was found that by paper ionophoresis, at pH 2.75, they could be well separated, since they were the only acidic peptides present. At this pH, -COOH groups are uncharged, while -SO3H groups carry a negative, and -NH2 groups a positive, charge. Peptides without cysteic acid were all positively charged, those with one cysteic acid were neutral and could be separated as a group, and those with two cysteic acids were negatively charged. If a slightly higher pH (3.5) is used for the ionophoresis, the -COOH groups become slightly charged and all the peptides containing one cysteic acid residue move slowly towards the anode and can be fractionated in this way. This method was found very useful for the separation and identification of cysteic acid peptides. Figure 1 is a tracing of an ionogram of an acid hydrolyzate of fraction A achieved in this way.

The sequence of fraction A was found to be as follows:

Gly-Ileu-Val-Glu-Glu-CySO<sub>8</sub>H-CySO<sub>8</sub>H-Ala-Ser-Val-CySO<sub>8</sub>H-Ser-Leu-Tyr-Glu-Leu-Glu-Asp-Tyr-CySO<sub>8</sub>H-Asp When a protein is hydrolyzed with strong acid, it gives rise not only to amino acids but also to a certain amount of ammonia. This is present in the form of amide groups on some of the aspartic and glutamic acid residues. It was thus necessary to determine the position of these groups (13). This was done by studying the ionophoretic rates and amide contents of peptides derived from enzymic hydrolyzates, since the amide groups are not split off by enzymes, whereas they are by acid. The position of the amide groups is indicated in Fig. 2 by the symbol NH<sub>2</sub>.

#### Arrangement of Disulfide Bridges

When the structures of the two chains of insulin had been determined, the only remaining problem was to find how the disulfide bridges were arranged. About this time it was shown by Harfenist and Craig that the molecular weight of insulin was of the order of 6000 and thus that the molecule consisted of two chains containing three disulfide bridges, and not of four chains as we had originally thought. The fact that fraction A contained four cysteic acid residues whereas fraction B had only two indicated that two bridges must connect the two chains together and that one must form an intrachain bridge connecting one part of the A chain with another part of the same chain.

In order to determine the distribution of the disulfide bridges, it was necessary to isolate, from unoxidized insulin, peptides containing intact cystine residues. These could then be oxidized to give cysteic acid peptides, which could be recognized since they had been found in the hydrolyzates of the oxidized chains. However, an unexpected difficulty arose in that, during hydrolysis, a reaction occurred which caused a random rearrangement of the disulfide bonds, so that cystine peptides were isolated which were not actual fragments of the original insulin, and it would have appeared from the results that every half-cystine was combined to every other half-cystine This disulfide interchange reaction could be demonstrated and studied when we used as a model system a mixture of cystine and bis-DNP-cystine, which reacted together to give mono-DNP-cystine

An ether-soluble colored substance was thus converted to a water-soluble colored substance, and the course of the reaction could be studied by measuring the distribution of color between ether and

It was found that there were two types of disulfide interchange reactions (14). One took place in neutral and alkaline solution and was catalyzed by —SH compounds. It is probably due to initial hydrolysis of the disulfide, which then catalyzes a chain reaction:

OH<sup>-</sup>

$$R_1 SSR_2 \longrightarrow R_1S^- + R_2SOH$$
 $R_1S^- + R_2SSR_4 \longrightarrow R_1SSR_2 + R_4S^- \dots$ 

In neutral conditions the reaction could be inhibited by —SH inhibitors; hence, it was possible to use enzymic hydrolysis to obtain cystine peptides (15). Thus, for instance, with chymotrypsin, a peptide was obtained which on oxidation gave the two cysteic acid peptides

and

The structure of the cystine peptide was thus:

Leu-Val-Cy-Gly-Glu-Arg-Gly-Phe-Phe

establishing the presence of a disulfide bridge between the two half-cystine residues nearest the C-terminal ends of the two chains.

It was not, however, possible to deter-

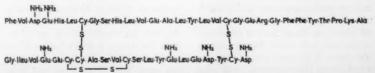


Fig. 2. Structure of insulin.

mine the positions of the other two disulfide bonds by means of enzymic hydrolysis, since no enzyme would split between the two consecutive half-cystine residues of the A chain. It was therefore necessary to reinvestigate the possibility of using acid hydrolysis.

The disulfide interchange reaction that occurred in acid solution was found to be different from that occurring in neutral and alkaline solution and instead of being catalyzed by -SH compounds was actually inhibited by them. This not only showed that a different reaction was involved but it also made it possible to prevent its occurring during acid hydrolysis. Thus, when insulin was treated with concentrated acid to which a small amount of thioglycolic acid was added, cystine peptides could be isolated which were in fact true breakdown products and from which the distribution of the remaining two disulfide bonds could be deduced. These are shown in Fig. 2, which shows the complete structure of insulin.

Of the various theories concerned with protein chemistry, our results supported only the classical peptide hypothesis of Hofmeister and Fischer. The fact that all our results could be explained on this theory added further proof, if any were necessary, of its validity. The results also showed that proteins are definite chemical substances possessing a unique structure in which each position in the chain is occupied by one, and only one, amino acid residue.

Examination of the sequences of the two chains reveals no evidence of periodicity of any kind, nor does there seem to be any basic principle which determines the arrangement of the residues. They seem to be put together in an order that is random, but nevertheless unique and most significant, since on it must depend the important physiological action of the hormone.

#### Biological Activity and **Chemical Structure**

As yet little is known about the relationship of the physiological action of insulin to its chemical structure. One approach to this problem was to study the insulins from different animal species (16). Since all insulins show the same activity, it could be concluded that differences would be found only in parts of the molecule that were not important for activity.

All the results given above were obtained on insulin from cattle. When insulins from four other species were studied by essentially the same methods, it was found that the whole of the B chain was identical in all species, and the only differences that were found in the three amino acids contained within the disulfide ring of the A chain, which in the cattle are

#### Ala-Ser-Val

and in the other species are as follows:

Pig, Thr-Ser-Ileu Sheep, Ala-Gly-Val Horse, Thr-Gly-Ileu Whale, Thr-Ser-Ileu These results suggest that the exact structure of the residues in this position is not important for biological activity, but it does not follow that the whole of the rest of the molecule is important.

The determination of the structure of insulin clearly opens up the way to similar studies on other proteins, and already such studies are going on in a number of laboratories. These studies are aimed at determining the exact chemical structure of the many proteins that go to make up living matter and hence at understanding how these proteins perform their specific functions on which the processes of life depend. One may also hope that studies on proteins may reveal changes that take place in disease, and that our efforts may be of more practical use to humanity.

#### References

- A. C. Chibnall, Proc. Roy. Soc. (London) 131B, 136 (1942).
- H. Jensen and E. A. Evans, J. Biol. Chem. 108, 1 (1935).
- H. Gutfreund, Biochem. J. 42, 544 (1948). E. J. Harfenist and L. C. Craig, J. Am. Chem. Soc. 74, 3087 (1952).
- F. Sanger, Biochem. J. 39, 507 (1945).
   A. H. Gordon, A. J. P. Martin, R. L. M. Synge, ibid. 37, 79 (1943).
- Synge, total. 31, 79 (1945).
  F. Sanger, ibid. 44, 126 (1949).
  —, ibid. 45, 563 (1949).
  R. Consden, A. H. Gordon, A. J. P. Martin,
  R. L. M. Synge, ibid. 41, 596 (1947). 9.
- F. Sanger and H. Tuppy, ibid. 49, 463 (1951). 10. , ibid. 49, 481 (1951). 11.
- 12. F. Sanger and E. O. P. Thompson, ibid. 53, 353, 366 (1953).
- and R. Kitai, ibid. 59, 509 (1955). 13
- (1955).
- H. Brown, F. Sanger, R. Kitai, ibid. 60, 556 (1955); J. I. H. Harris, F. Sanger, M. A. Naughton, Arch. Biochem. Biophys. 65, 427

# Elmer Martin Nelson, Government Scientist

Elmer Martin Nelson will be remembered for his important contributions to science, particularly in the field of nutrition. Evidence that eminence in the field of science can be attained in the service of government is clearly demonstrated in the career of this man, who was born in Clark, South Dakota, more than 66 years

A man of stature, both physically and mentally, he possessed a delightful sense of humor, as well as the dignity and modesty befitting a "servant of the people." His firm but friendly attitude earned for him the respect and admiration of his associates. In the key position he held for many years in the Food and Drug Administration, his philosophy of law enforcement was to promote to the highest degree possible a voluntary compliance with pure food and drug law, through mutual understanding and respect. His straightforward discussion of difficult problems with scientists in industry led to increased confidence and developed a spirit of willingness to cooperate with the Food and Drug Administration. He continuously sponsored this theme of education and practiced frank discussion of enforcement problems with representatives of the food and pharmaceutical industries. In this association he helped to guide with integrity and knowledge the development and utilization of research in nutrition. The efforts of those who preyed upon consumers by exploiting new developments in nutrition science to their own commercial benefit were repugnant to his strong sense of scientific honesty. Through his lectures, his participation in symposia, his writings, and his testimony in many court contests, he was a leader in the campaign against quackery in the field of nutrition.

A dedicated scientist, he was actively interested in the training and development of the younger people with whom he associated. With his encouragement and guidance, a good number of his staff continued in graduate studies to complete their requirements for higher degrees. Those who had the privilege of working under his supervision will remember him as a stimulating and friendly teacher. Thorough and perceptive in his approach, he had a keen ability to detect the shortcomings of an experimental plan and to call attention to the over-all significance of experimental results.

His contributions to the scientific literature are many and varied. His service to the food industry was recognized in 1949, when he received the American Grocery Manufacturers' award. It was one of his proudest moments when, in 1957, the Babcock-Hart award was presented to him by the Institute of Food Technology.

A pioneer in vitamin research, he carried out his graduate and postgraduate studies at the University of Wisconsin under professors Steenbock and Hart during the period that saw the differentiation of vitamins A and D. His work contributed to knowledge of vitamin A—of its characteristics and the biological means for its estimation. His experiments pointed out the relationship between vitamin D and ultraviolet light and contributed to the basis for the Steenbook patent for irradiation of foods.

6

of

d

d

ty nd he n-nts m-nis

The year 1926 marked the beginning of what was to be a long and effective career in the broad field of public health. Early studies in the U.S. Department of Agriculture, conducted in association



Elmer Martin Nelson

with D. Breese Jones, provided important information in identifying selenium as the toxic agent in wheat grown in certain areas of the Midwest. During this same period much of his attention was devoted to the standardization of biological methods for measuring the fatsoluble vitamins—methods which later provided, in the *United States Pharmacopeia*, the first official tests for these substances.

When the time came in 1935 for the Food and Drug Administration to devote close attention to the many vitamin preparations appearing on the market, the logical choice for the leader of a group in this field was E. M. Nelson. Here it was felt his knowledge of vitamins and their place in nutrition could be utilized advantageously in the further development of methods of assay and related nutrition research. And so it was. Many of the studies conducted under his able tutelage resulted in the standard and official procedures now in use.

Elmer Nelson's name is recorded in scientific history as one of those responsible for the establishment of international standards for vitamins, an important step in the nutrition field. He was the United States representative to the first international conference on vitamins.

His associations in the American Medical Association's Council on Drugs and Council on Foods and Nutrition, his membership on the Vitamin Advisory Board of the United States Pharmacopeia, his activity on the Food and Nutrition Board of the National Research Council, his efforts as a general referee for the Association of Official Agricultural Chemists, and his extensive participation in many other scientific organizations provided close contact with eminent research workers and those influential in this field of endeavor. These contacts enabled him in his regulatory position to speak with authority on scientific matters and to disseminate his views most effectively as well as to have firsthand information of developments in the field of biochemistry and nutrition. He was thus well able to anticipate regulatory problems that might arise as a result of new findings on nutrition.

He was the principal nutritionist for the Government in the many public hearings that led to establishment of standards for enriched foods and of regulations pertaining to the labeling of foods that have special dietary uses. In his testimony he was ever mindful of the problems of the manufacturer, but he had as well an understanding of the phrase "to promote honesty and fair dealing in the interest of the consumer." He was a scientist to whom consumers the country over unknowingly owe a great debt.

His was a life of devotion to his profession. He was active to the very end, and his unexpected death, on 24 December 1958, came as a shock and brought great sorrow to his host of friends and associates.

CHESTER D. TOLLE
U.S. Food and Drug Administration,
Department of Health, Education,
and Welfare, Washington, D.C.

## News of Science

Conservation Bill Faces Test in Senate—Committee Asks Whether We Need the "Tonic of the Wilderness."

After 10 years of talk and two of Congressional committee hearings, a bill designed to preserve some of the country's major wilderness areas may come before the Senate this month. The wilderness bill, on which the Senate Interior and Insular Affairs Committee has recently completed hearings, would set aside certain primitive park and forest areas now under federal administration control to make up a national wilderness preservation system. In the language of the bill, S. 1123, a wilderness is "an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." Under the provisions of the bill, such areas would be preserved in their natural state for future generations.

#### Interest Dates From 1949

Legislation for this purpose has been under consideration in Congress since 1949, but the first committee hearings were not held until 1957. Two bills-S. 1176 and S. 4028-have been introduced and examined by the committee since that time. The bill currently under consideration, which was introduced by Senator Humphrey (D-Minn.) and 17 other senators, has been modified as a result of these earlier sessions. Field hearings on the Humphrey bill were held 30 March to 2 April in Seattle, Wash., and Phoenix, Ariz. One other actiona review of the modified bill by the Department of Agriculture and the Bureau of the Budget-will clear the way for a vote of the Interior and Insular Affairs Committee as to whether to send the bill to the Senate floor. It is expected that the vote will take place this month.

#### **Provisions Explained**

The bill would not add any new land to the amount now owned by the government. Rather, it would identify certain sections of that land as "wilderness" areas and provide a sound legal basis for their protection and administration. As things now stand, such a basis is lacking, and proponents of the bill feel that, without it, economic pressures will eventually result in the exploitation of these areas.

If the bill were passed tomorrow, the only change from present practice would be that the wilderness areas would have this new legal status, and that they would be consciously preserved as wilderness areas by the administrative agency involved. Some existing rights, for example grazing rights, would be continued. However, mining and forestry rights, where they now exist, would be terminated in the designated lands.

The wilderness areas, which, it is estimated, comprise 5.2 percent of the land now owned by the government, are scattered throughout the country, although the majority of them are in the West. They include the Teton Wilderness Area in Wyoming, the Gila Wilderness area, parts of Superior National Forest in Minnesota, Pisgah National Forest in North Carolina, Mount Hood National Forest in Oregon, and a great many others. All told, it is estimated that the bill would put between 50 and 55 million acres of the nation's 2.3 billion into the wilderness system.

Other provisions of the bill would give the Secretary of Agriculture 20 years to determine which parts of the national forests should go into the system, the Secretary of the Interior 10 years to determine which parts of the national parks should be included, and would give the Congress the right to veto any proposed increases or reductions in the wilderness system after its establishment. In addition to these provisions, allowance is made for the inclusion of lands belonging to other governmental departments, Indians, and private individuals if the involved parties choose to donate them.

#### Commercial Groups Opposed

Opposition to the wilderness bill comes from two main centers—industrial and agricultural associations such as the American Mining Congress and the American National Cattlemen's Association, and the various chambers of commerce from the local level up to the national. The arguments these groups put forth vary, but three main points seem to form the burden of their case. The first is that the establishment of a

wilderness system would benefit only a small fraction of the country's peoplethose with the time, money, inclination, and, as many witnesses noted, the physical stamina, necessary to reach and explore such areas. A second point of the opponents maintains that pressure of population will require the exploitation of these lands if needs for basic resources and employment are to be met in the future. This point is particularly stressed by representatives of commercial interests in the western states who say that their growth and that of the states will be impeded if the wilderness lands cannot be used. Violation of existing practices is the core of the third major point of the opponents of the bill. According to this view, the current policy of the government-"multiple use," is working well in the administration of forests and parks. The multiple-use policy-a direct application of the doctrine of the "greatest good for the greatest number"-allows many interested groups to use federal land if, in the opinion of the secretary of the relevant department, such use will not significantly alter it.

As an argument, not against the bill, but favoring a delay in any action on it, many witnesses cited the work of the Outdoor Recreation Resources Review Commission. This group, appointed in 1958, is studying the country's recreational needs and potential under the chairmanship of Lawrence Rockefeller. Because its report is to be given to Congress in 1961, many witnesses suggested that that year would be the proper time to initiate any legislative action.

#### Conservationists Favor Passage

The bases of the case for the wilderness bill, which has wide popular support, particularly in the West, according to many witnesses, range from Thoreau's cry "We need the tonic of the wilderness" to Senator Humphrey's more prosaic point that the "hue and cry" of the commercial interests is "way out of proportion to the area of land involved and to the value of these lands in the potential production of commercial resources." The centers of support for the bill are the conservation groups, outdoor and sport groups, and, as the Seattle testimony seemed to indicate, the people of the areas involved. One other major organization, the AFL-CIO, has also taken a supporting position. Some observers suggest this may reflect the fact that the National Association of Manufacturers is opposed to the bill.

The proponents of the bill seem to feel that their case is self-evident, and for this reason, perhaps, tend to content themselves with criticism of the opposing case. Supporting Humphrey's claim of exaggeration, Senator Proxmire (D-Wis.) said during last year's hearings: "We no more need the 14 million acres

in the national wilderness forest areas for the few commodities they may yield than we need to melt down the bronze in our monuments or to grow crops on historic battlefields." Put somewhat more seriously, the conservationist's reply to the need-for-resources argument runs like this, according to a staff member of the Senate committee: Should we destroy the remaining wilderness areas just to delay for a decade or so the inevitable shift from current sources of basic materials to the new ones the future will surely demand?

of

n

es

e

d

r-

11

C-

g

ď

ct

1-

e-

h

1,

t,

1e

in

a-

ne

r.

n-

d

ıe

m

re

of

of

ed

ne

e-

OF

3-

le

so

b-

ct

ad

s-

#### Passage Held Possible

The Senate Interior and Insular Affairs Committee, in voting whether to send the wilderness bill to the Senate floor, will provide the first test of strength on the measure. The committee is comprised of ten Democrats and five Republicans, all of whom live west of the Mississippi River. Because the commerce of the West has most to lose through passage of the bill, it is expected that the Senators from this area will attempt to amend the measure in such a way as to protect commercial interests. With this general revision, according to informed sources, the bill will have an even chance of getting from the committee to the Senate floor. Once there, according to these sources, it has a betterthan-even chance of passage. However, the House of Representatives, which has the companion bill, HR 1960, before it, is expected to wait until the Senate acts before starting hearings. This delay, in addition to the fact that 26 of the 31 members of House Interior Committee are also from middle and far western states, makes passage of the wilderness bill by the whole Congress this year a chancy business.

# Compton Criticizes Secrecy in Science

The Subcommittee on Constitutional Rights of the Senate Committee on the Judiciary held its first public hearing on secrecy in science on 28 April. The hearing was a phase of the subcommittee's continuing study of freedom of information and secrecy in government. Arrhur H. Compton, Nobel-Prize-winning physicist of Washington University, presented the day's testimony.

In opening the session, Senator Thomas C. Hennings, Jr. (D-Mo.), chairman of the subcommittee, explained that the purpose of the new hearings was to explore the extent to which restrictions on the free dissemination of scientific information may be interfering with scientific development and progress in the United States. He commented that the subcommittee, in the course of its work

in the field of freedom of information, had heard many complaints to the effect that undue secrecy has been hindering the work of scientists and has even caused many young people to avoid science as a career. He emphasized that the aim of the subcommittee's present study is to seek the views of the scientists themselves in an attempt to determine whether or not this actually is so. Hennings said: "If this is so, it is stupid and shortsighted, and something should be done about it immediately."

As a preliminary step in the subcommittee's study of secrecy and science, Hennings has written to all American Nobel-Prize-winning sciertists to ask for their comments. As soon as these have been received and collated, they will be made a part of the record of the hearings. In the course of its present study, the subcommittee plans to consider the opinions of as many scientists in as many different fields as possible.

As the first witness in the new hearings, Compton opened his remarks by observing that the situation relating to secrecy in science had improved substantially since 4 years earlier, when he had testified before Congress on the subject. He referred to the difficulties that some scientists had encountered in applying for passports to attend meetings abroad, mentioning especially Linus Pauling's passport problems before he went to Europe to receive the Nobel Prize in 1954. He also described briefly the obstacles that arose from the requirement for political screening of visiting scientists, when international meetings were held in this country. He observed that the present policy, which requires a strong reason for denial of passports and visas, has eased the situation and represents a "substantial advance."

He pointed out that at the time of his earlier testimony there was a rather "loose and indiscriminate questioning of the loyalty of many, many scientists." He said that although this situation has also been alleviated, the effect of the questionings of past years is still considerable. He commented: "I find that there are, particularly among younger men, doubts about the advisability of entering the scientific professions for fear that they will be considered as persons unloyal to the United States."

#### The Scientist's Role

After these preliminary remarks, Compton described for the subcommittee some of the ways in which secrecy in science can retard scientific advance. He urged that the ultimate responsibility for security in a research program rest with the scientist-administrator of that program. Excerpts from his testimony follow.

"A point which I would like to emphasize today is the importance of putting the responsibility for loyalty and maintenance of appropriate security in the hands of those who are responsible for conducting research. This would apply not only for research, which is my own special interest but, as far as I can see, likewise to such matters as conducting the work on the national defense or on the international policy of the United States. . . .

"Fifty years ago it was the common practice in science for a man to put a trademark, so to speak, on a certain aspect of science which he himself had started to investigate. If he would publish a paper, it was notice to his scientific colleagues that this was his little private province and that other people should keep off the ground and let him develop it and see what he could do.

"This is a point of view which has almost completely disappeared within the last generation. And it has disappeared because it has been found that the speed of advance has been much greater when a number of people approach the same problem from different points of view and compare ideas so that each can contribute, can fill in gaps in the other person's information, and thus the information grows more rapidly.

idly.

"This has been found mutually so advantageous that it has become the modern pattern of science, and the openness of information in science is a part of this same process that has been going on with the development of patents in industry and so on.

"It has come in recent years, since World War II, also into the field even of national defense, which is perhaps the most sensitive field that we have, where the present standard is generally accepted that the things of fundamental scientific interest, meaning by 'fundamental' science the science which is basic to the development of various aspects of weapons, will be made open but one will retain for one's self, that is, for the welfare of the nation, information with regard to the particular methods of application of this scientific knowledge which would involve special techniques for development of weapons or development of tactical use of weapons and things of that kind. These are things which are of such immediate importance to the nation concerned that they will be maintained. . . .

#### Clearance Procedure Inefficient

"One of the real difficulties that has come in connection with the development of the scientific aspects of national defense has been the question of clear-

"This has become really a highly organized—I think I would describe it as a 'bureaucratic'—matter in which there is a significant part of the responsibility put in the hands of bureaus which have their own interests involved quite independent of the interests of advancing the scientific knowledge that may be the

concern of groups. . . .

"I would take this as a typical example: Suppose a man is employed by the National Bureau of Standards on study of a problem in radioactivity. He will presumably have been cleared for work on this problem in Washington on this job. We may well suppose that in Los Alamos there comes to be a problem which needs investigation by a person of his ability, and the director of the Los Alamos scientific laboratory makes arrangements with the director of the Bureau of Standards to have this man transferred.

"But before he can be transferred, he will have to go through channels of clearance which will involve perhaps many weeks before the transfer can be made. And it may well be that his usefulness is over, that the job which he was supposed to do will already have been done by some other method with the expenditure of considerably more time and effort.

"This is the kind of thing to which I refer as the security techniques frequently destroying their own objective, because they become too highly organized.

"This seems to me to be at the moment one of the major problems that we face as a nation in connection with the security problem—namely, making it possible to make available to the part of the nation involved the skills of people in other parts of the nation, but, more generally, developing our security system in such a way that the essentials of secrecy, insofar as they are essential, can be maintained while transfers are made of individuals from one place to another for work. . . .

"[There should be] a greater centralization [of the security system], but with this thing kept in mind: That the responsibility for getting the job done is the thing that must be maintained as the matter of top importance. . . .

"I would personally like to see an office of security so developed that it can be used as a source of reference and advice to the individuals who are concerned with getting jobs done..."

#### AAAS-Westinghouse Science Writing Awards

The American Association for the Advancement of Science has announced the establishment of two \$1000 AAAS—Westinghouse Science Writing Awards to recognize outstanding science writing in the nation's newspapers and maga-

zines. The awards are provided by the Westinghouse Electric Corporation through the Westinghouse Educational Foundation. The prizes will be made annually for excellence in science writing in the natural sciences, including engineering and technological applications but excluding medicine.

In making the announcement, Dael Wolfle, executive officer of the AAAS, said that the new awards program is intended "to recognize and encourage outstanding popular science writing, to stimulate public interest, and to foster a deeper understanding of the significance of science by the general public." He observed:

"Science and technology play a dominant role in human affairs today. Therefore, a broadly informed citizenry is essential, not only to continued scientific progress through public support of science but also to the solution of problems of major public concern which arise

from such progress.

"Clear, accurate, impartial science writing in magazines and newspapers is an effective force in scientific communication to the nation as a whole. In administering the Westinghouse Science Writing Awards, the AAAS helps fulfill its purpose of advancing science directly and indirectly, and aids in discharging the responsibility all scientists feel toward building a broader public understanding of scientific developments and their implications to society."

The first of the new awards will be made during the winter meeting of the AAAS at Chicago in December 1959. The awards will be presented at the annual dinner of the National Association of Science Writers, an affiliate of the AAAS. Graham DuShane, editor of Science, will act as the administrator for the awards program.

To be eligible for the 1959 awards, a magazine article or a newspaper or press association report must have appeared in print between 1 October 1958 and 30 September 1959 in publications within the United States. Either a single article or a series of articles is eligible for an award.

In addition to the \$1000 cash prizes for the authors, citations will be awarded to the newspaper and magazine in which the prize-winning articles appeared. At the discretion of the judges, special citations also may be awarded for distinguished service in science journalism.

Persons prominent in journalism, science, and public affairs will serve as the board of judges for the new program. The judges will be selected in the near future.

Entries in the Westinghouse Science Writing Awards competition will be judged on the basis of their initiative, originality, scientific accuracy, clarity of interpretation, and their value in promoting a better understanding of science by the layman. Deadline for entries in the 1959 competition is 10 October.

The new competition is open to all who are engaged in science writing, irrespective of their professional employment or what previous awards they may have won in other competitions. However, only articles that have appeared in magazines directed to the general public are eligible. This excludes work that has appeared in trade journals or professional magazines.

#### International Atomic Agency Plans New Activities

At the end of its April meetings, the board of governors of the International Atomic Energy Agency decided that the agency should make a study of problems involved in the setting up of one or more isotope training centers in Arab and other countries in Africa and the Middle East. The director general was authorized to send experts to carry out surveys on the spot. Requests for IAEA's assistance in establishing such training centers had been received from several member countries. Letters from member countries had suggested that the existing facilities in Cairo and Ankara be used as a basis for such centers.

The board also accepted a United States offer of \$600,000 for the agency's functional laboratory to be built at Seibersdorf near Vienna; the Netherlands will contribute a gamma spectrometer

for the laboratory.

During its 2-week session, the board dealt with several other issues concerning major sectors of the agency's activities. It approved draft agreements with the U.S.S.R., the United Kingdom, and the United States for the supply of nuclear materials and authorized the director general to sign the agreements. The U.S.S.R. has agreed to supply 50 kilograms of uranium-235, the U.K. 20 kilograms, and the U.S. 5000 kilograms. The agreement with the U.S. also provides for the supply of additional quantities of nuclear materials matching the total of such supplies provided by other member states prior to 1 July 1960.

Another important subject before the IAEA governors was the agency's technical assistance activities. The group approved the sending of two preliminary assistance missions—one to Argentina, Brazil, and Venezuela, and the other to China (Taiwan), Japan, Korea, the Philippines, and Viet-Nam—to make detailed surveys for determining possible lines of agency assistance to these countries. A third mission will visit Argentina and Brazil to investigate the possi-

bilities of utilizing nuclear power at certain specific locations. In addition, the agency will provide ten experts for Burma, Greece, and the United Arab Republic.

The board also approved a project for the preparation, in conjunction with UNESCO, of a manual on atomic energy and its peaceful applications for use in secondary schools in member countries. The next series of board meetings will begin on 16 June.

#### Final Report of Advisory Committee for Aeronautics

The 44th and final report of the National Advisory Committee for Aeronautics was released at the end of April. The NACA, established by Congress in 1915 to coordinate and conduct aeronautical research, was absorbed by the National Aeronautics and Space Administration under legislation enacted last year. The NASA took over facilities, property, equipment, and staff of the NACA on 1 October 1958.

NACA's concluding annual report contains a history of the agency, written by its last two chairmen, Jerome C. Hunsaker and James H. Doolittle. Hunsaker traced the NACA history for the first 40 years; Doolittle covered the final 4 years. In addition to the history, the 115-page report contains financial, personnel, and publications reports, plus a series of word and photo essays on various research projects.

#### **Academic Freedom Declines**

ı

g

s

d

1-

S.

)-

1-

ie

h-

pry a, to

ie

ce

le

The decline of academic freedom in American universities during the 1950's is indicated by a survey that was undertaken at the request of the Fund for the Republic. Paul F. Lazarsfeld and Wagner Thielens, Jr., of Columbia University conducted the study and have recently published their findings in a volume entitled The Academic Mind: Social Scientists in a Time of Crisis. The report is based on questionnaire answers by 2451 social scientists associated with 165 college-level institutions.

Those queried listed 990 different instances of administrative action—most of them concerned with political conduct or belief—that resulted in 188 discharges at 102 of the 165 institutions, 40 forced resignations, 118 withheld promotions, and 99 instances of other kinds of discipline. Because of these incidents, it was found, both academic freedom and teacher morale suffered. It was reported that, while some instructors showed defiance by joining so-called controversial groups or reading controversial publications, more compromised by qualifying

their classroom statements. The latter also stopped taking part in political work, making public appearances, subscribing to certain magazines, or belonging to certain organizations.

#### **Identification Method**

A new method for rapidly identifying war or disaster victims has been developed by V. Sassouni [Temple Law Quart. 31, 1 (1958); J. Forensic Sci. 4, 1 (Jan. 1959)]. This involves eight different cranial and facial measurements taken from standard x-ray negatives. These are fed to an electronic computer, which selects the card for the proper individual from a coded file.

The great disadvantage of this novel and apparently accurate method of identification is the fact that an extensive catalog of coded individual measurements would have to be kept on file at some central agency. This might be feasible on a limited scale—for example, for the armed forces—but it seems unlikely that the method could ever be successfully applied to the population at large.

#### Advanced Degrees Earned, 1957-58

The Office of Education has recently released figures on the number of degrees earned in institutions of higher education during 1957–58. A comparison of these totals with those of the preceding year is provided in Table 1.

The compilation shows that, in all fields considered together, the number of degrees earned has increased by 7.5 percent as compared with 1956-57. Science registered a gain of 9.5 percent in bachelor's degrees; engineering, a gain of 13.1 percent.

There was an increase of 322 in the number of master's degrees granted in science but no significant change in the number of doctorates. Perhaps it should also be noted that biology barely retained its lead over the physical sciences in degrees granted at the bachelor level.

#### List of International Meetings

The National Science Foundation has announced that the first issue of the World List of Future International Meetings will be released in June by the International Organizations Section of the Library of Congress. This monthly calendar, which is supported by an NSF grant, will furnish a record of all meetings drawing on three or more nations that are to be held anywhere in the world during the next 3 years, giving the sponsors and the addresses of organizing committees wherever possible. The subjects will be indexed for convenient use. The new list will supersede NSF's List of International and Foreign Scientific and Technical Meetings, which ceased publication with the January 1959 issue.

The World List will be issued in two parts. Part I will be devoted to science, technology, medicine, and agriculture. Part II will record meetings in the social, cultural, humanistic, and commercial fields. The World List will be available from the Superintendent of Documents, Washington 25, D.C., at a subscription price to be announced.

The Library of Congress will welcome notices of any forthcoming international meetings. Please send the information, together with all inquiries about the World List, to: International Organizations Section, General Reference and Bibliography Division, Library of Congress, Washington 25, D.C.

#### Cockcroft Calls Space Program Extravagant

Sir John Cockcroft, chief of Britain's atomic research program is reported to have said that the "fantastic amounts" spent by the United States and the Soviet Union in trying to put a man into space could be better employed in medical and biological research on earth. The 1 May New York Times described a news conference in Melbourne, Australia, at which Sir John commented that "normal" space research was not a waste

Table 1. Earned degrees, 1956-1957 and 1957-1958.

	Bachelor		Ma	ster	Doctor	
Field —	1956–57	1957–58	1956-57	1957-58	1956–57	1957–58
All	340,347	365,748	61,955	65,614	8,756	8,942
Agriculture	7,943	8,312	1,549	1,480	353	353
Biology	17,868	14,408	1,801	1,852	1,103	1,125
Mathematics	5,546	6,924	965	1,234	249	247
Physical sciences	12,934	14,352	2,704	3,034	1,674	1,655
Psychology	6,191	6,930	1,095	836	550	572
Subtotals	46,482	50,926	8,114	8,436	3,929	3,952
Engineering	31,211	35,332	5,233	5,788	596	647
Totals	77,693	86,258	13,347	14,224	4,525	4,599

of time, but that he believed the "thousands of millions being spent by the United States and Russia to get a man into space is not warranted. He said, further: "Space travel will not be of great use to humanity. I think there will be great difficulty in getting such a spaceman back to earth safely."

#### Summer Program for High-School Students

The National Science Foundation has announced that this summer it will support 112 Secondary-School Student Training Programs at 105 colleges, universities, and nonprofit research organizations in 35 states, the District of Columbia, and Puerto Rico. This program is designed to provide secondary-school students of high ability with college-level summer work in science, mathematics, and engineering that is designed especially for them. As a result of successful experimental programs last year, the NSF 1959 summer program has been expanded to include additional institutions and represent wide geographic areas. In most instances the sponsoring institutions bear some of the costs. Total outlay by the foundation for this work this year will be approximately \$1.6 mil-

#### Grants, Fellowships, and Awards

Neurology. The Public Health Service's National Institute of Neurological Diseases and Blindness recently reported on the status of its Special Traineeship Program in neurological and sensory disorders and called attention to additional opportunities for advanced study and research training. Since the inception of the program less than 3 years ago, 163 persons have received from 1 to 3 years of training at 48 institutions in the United States and 16 institutions in seven foreign countries.

To qualify for an award, a candidate should have an M.D., Ph.D., or other equivalent degree, and at least 3 years of training or experience pertinent to the training for which he seeks support. The applicant either must be an American citizen or must have filed a Declaration of Intent. Traineeship awards generally are made for not less than 9 months and not more than 1 year. However, all awards are subject to renewal for periods up to 5 years. Stipends are determined individually and may range from \$6500 to \$17,500 a year.

Requests for information about the Special Traineeship Program and application forms should be addressed to: Chief of Extramural Programs, National Institute of Neurological Diseases and Blindness, National Institutes of Health, Bethesda 14, Md.

Science teaching. As a part of the AAAS Science Teaching Improvement Program, recently extended under a new grant to AAAS from the Carnegie Corporation of New York, a limited number of grants for research projects, averaging \$1000 each, will be made to science staff members of small colleges and teachers colleges. Consideration will be given only to proposals in which preservice science teachers will be involved in the research project. The first grants will be made early in June. For additional information, write to J. R. Mayor, Director of Education, AAAS, 1515 Massachusetts Ave., NW, Washington 5, D.C.

#### **News Briefs**

The complete works of the late Irving Langmuir are being collected for publication as a set of six volumes by Pergamon Press, Inc., of London and New York. Langmuir, who was associated with the General Electric Research Laboratory from 1909 until his death in 1957, was the first American industrial scientist to receive a Nobel Prize. A group of 29 scientists from many different countries will serve as members of an editorial advisory board, which will be under the chairmanship of Guy Suits, vice president and director of research at General Electric. Peter Debye of Cornell University and Sir Eric Rideal of the Imperial College of Science and Technology, London, are deputy chairmen of the editorial group.

The National Aeronautics and Space Administration has announced that the first two space sciences working groups have been formed and 13 government. university, and industrial scientists have accepted membership on them. The new groups are Orbiting Astronomical Observatories, to be headed by Nancy Roman of the NASA Office of Space Sciences, and Satellite Ionospheric Beacons, with J. C. Seddon of the NASA Space Projects Center as chairman. A number of such NASA groups are being planned under a program that is directed by Homer E. Newell, Jr., NASA assistant director for space sciences.

The first issue of the Bulletin of the International Atomic Energy Agency was released last month. The new publication is available in English, French, Russian, and Spanish; it will appear quarterly. The purpose of the bulletin is to disseminate information about IAEA in layman's language. Effective dissemination will depend on the extent to which the material presented is suitably reused,

for the bulletin itself will not have a mass circulation. For information write to the Division of Public Information, IAEA, Vienna, I, Kärntnerring, Austria.

Massachusetts Institute of Technology has received from Mr. and Mrs. Cecil H. Green of Dallas, Tex., a gift of \$2,527,500, for the creation of a Center for Earth Sciences. The proposed building will house laboratories for work in geophysics, meteorology, oceanography, and related fields. Green, an M.I.T. alumnus, is a vice president of Texas Instruments, Inc.

A generally downward trend in rates of mortality from heart disease among persons in middle life in the United States is reported for the 8-year period 1949 through 1956 by the Metropolitan Life Insurance Company. This is in sharp contrast to the generally upward trend prior to 1949. Heart disease, however, continues to be the most serious health problem among people in the 45-64 age group, accounting for twofifths of the total number of deaths and constituting a major cause of sickness and prolonged disability. The death rate from heart disease in the United States during 1955-56 for individuals in that age group averaged 6.8 per 1000 for white males and 2.4 for white females, a ratio of nearly 3 to 1.

A ground-breaking ceremony will be held on the site of the new National Library of Medicine building on the grounds of the National Institutes of Health, Bethesda, Md., on 12 June. Arthur S. Flemming, Secretary of the Department of Health, Education, and Welfare, will deliver a short address. Senator Lister Hill, coauthor of the National Library of Medicine Act, will turn the first spadeful of earth. The chairman of the Board of Regents of the National Library of Medicine, Champ Lyons, will be the chairman of the proceedings.

The United Nations has announced the extension of the prepublication period for the Spanish edition of the Proceedings of the Second United Nations International Conference on the Peaceful Uses of Atomic Energy to 30 June 1959, during which time complete sets may be ordered at the special price of \$166. It is further announced that the Spanish edition of the proceedings will consist of 13 volumes, rather than the previously announced 15 volumes.

The Engineers Joint Council, representing more than a third of the nation's engineers, backed the creation of a Cabinet-level Department of Science and Engineering in a statement before the Subcommittee on Reorganization and

International Organizations of the Senate Committee on Government Operations at a Washington hearing on 16 April. Enoch R. Needles is president of the organization, which is a federation of 21 societies of professional engineers with an aggregate membership of 300,-000.

#### Scientists in the News

OTTO STRUVE has been named the first director of the National Radio Astronomy Observatory at Green Bank, W.Va. The National Science Foundation is supporting the construction and operation of the observatory through a contract with Associated Universities, Inc., which is headed by Lloyd V. Berkner. Struve has been professor of astronomy at the University of California, and director of its Leuschner Observatory, since 1950. He will assume his new post on 1 July. An astronomer of international reputation, Struve has published approximately 1000 papers concerned with the problems of stellar spectra and other aspects of astrophysics.

The National Radio Astronomy Observatory was established to supplement the facilities for research astronomers by providing large and precise radio telescopes not hitherto available. Among these new instruments are the 85-foot Howard E. Tatel precision radio telescope recently put into operation, the 140-foot radio telescope now under construction, and a variety of auxiliary devices for radio astronomy. The observatory is operated by a small permanent staff in cooperation with an increasing number of visiting scientists from both American and foreign institutions.

Struve was born in Kharkov, Russia, in 1897, and received a diploma of first rank at the University of Kharkov in 1919. He came to the United States in 1921 as a graduate student and an assistant in stellar spectroscopy at the Yerkes Observatory of the University of Chicago. He became a naturalized American citizen in 1927. After ascending through the various ranks from instructor to full professor at the University of Chicago, he was appointed director of the Yerkes Observatory in 1932. He also organized and founded the McDonald Observatory of the University of Texas, which was operated by the University of Chicago, and served as director of both observatories from 1932 to 1947.

Struve was managing editor of the Astrophysical Journal from 1932 to 1947; president of the American Astronomical Society from 1947 to 1950; and president of the International Astronomical Union from 1952 to 1955. The long list of honors, both national and international, that have been conferred



Otto Struve

on him include membership in the National Academy of Sciences, the American Philosophical Society, the Royal Society of London; corresponding membership in the French Academy of Sciences; and foreign membership in the academies of the Netherlands, Denmark, Norway, and Sweden.

The new appointment continues a tradition, for Struve is a member of a renowned family of astronomers. His great-grandfather, Friedrich George Wilhelm Struve, built and became the first director of the famous observatory at Pulkovo, Russia, a post that passed to his son upon his death. His uncle moved and completely remodeled the old observatory of Berlin, Germany. His father was professor of astronomy at the University of Kharkov.

The following scientists received awards during the 96th annual meeting of the National Academy of Sciences-National Research Council, which took place at the academy's headquarters in Washington at the end of April.

MARTIN W. JOHNSON of the Scripps Institution of Oceanography received the Agassiz Medal for contributions to oceanography.

CHARLES H. TOWNES, professor of physics at Columbia University, received the Comstock Prize for his investigations in microwave spectroscopy and his pioneering work on the maser.

HERBERT FRIEDMANN, acting head curator, department of zoology, U.S. National Museum, Smithsonian Institution, received the Daniel Giraud Elliot Medal for his book, *The Honey-Guides*.

TRACY M. SONNEBORN, distinguished service professor of zoology at Indiana University, received the Kimber Genetics Award for his fundamental contributions to the study of the genetics of microorganisms.

EUGENE L. OPIE, member of the Rockefeller Institute, received the Jessie Stevenson Kovalenko Medal for outstanding contributions to the medical sciences.

ROMAN KOZLOWSKI, department of paleontology at the University of Warsaw, Poland, received the Mary Clark Thompson Medal for his fundamental contributions to paleontology.

The election of 30 new members was also announced at the annual meeting. Election to membership in the academy is considered to be one of the highest honors which can be visited upon an American scientist. The new members follow.

PHILIP H. ABELSON, director of the geophysical laboratory of the Carnegie Institution of Washington.

WALKER BLEAKNEY, Brackett research professor at Princeton University.

DAVID M. BONNER, professor of microbiology at Yale University.

TOM W. BONNER, professor of physics at Rice Institute.

WALTER H. BRATTAIN, research physicist at Bell Telephone Laboratories and winner of the Nobel prize in physics in 1956.

LEO BREWER, professor of chemistry at the University of California, Berkeley.

FRANK BRINK, Jr., dean of graduate studies at the Rockefeller Institute.

JENS C. CLAUSEN, professor of biology at Stanford University.

SAMUEL EILENBERG, professor of mathematics at Columbia University.

JOHN D. FERRY, professor of chemistry at the University of Wisconsin.

KURT O. FRIEDRICHS, professor of applied mathematics at New York University.

H. BENTLEY GLASS, professor of biology at Johns Hopkins University.

MELVILLE J. HERSKOVITS, professor of anthropology at Northwestern University.

HERMAN M. KALCKAR, professor of biochemistry at Johns Hopkins University.

KONRAD B. KRAUSKOPF, geologist with the U.S. Geological Survey.

I. MICHAEL LERNER, chairman of the department of genetics at the University of California, Berkeley.

RUDOLPH L. B. MINKOWSKI, research associate at the California Institute of Technology.

HARRY F. OLSON, acoustic research director at the laboratories of the Radio Corporation of America.

CARL PFAFFMANN, professor of psychology at Brown University.

RICHARD J. RUSSELL, professor of physical geography at Louisiana State University.

JOHN A. SIMPSON, professor of

ts

ne

physics at the Institute for Nuclear Studies of the University of Chicago.

DEAN S. TARBELL, professor of organic chemistry at the University of Rochester.

HENRY TAUBE, head of the chemistry department at the University of

JAMES A. VAN ALLEN, head of the department of physics at Iowa State University.

CECIL J. WATSON, head of the department of medicine at the University of Minnesota.

GREGOR WENTZEL, professor of physics at the University of Chicago.

FRED L. WHIPPLE, director of the Smithsonian Astrophysical Observatory, Cambridge, Mass.

WILLIAM B. WOOD, JR., vice president for medical affairs and professorelect of microbiology at Johns Hopkins University School of Medicine.

CLARENCE M. ZENER, director of the Westinghouse Research Laboratories.

RAYMOND E. ZIRKLE, professor of radiobiology at the University of Chicago.

ETHAN A. H. SHEPLEY, chancellor of Washington University, received the second Alexander Meiklejohn Award for Academic Freedom at the 45th annual meeting of the American Association of University Professors in Pittsburgh, Pa. The award was established last year in honor of Alexander Meiklejohn, former president of Amherst College, through a gift by alumni and former faculty members of the Experimental College at the University of Wisconsin, which Meiklejohn directed from 1927 to 1932.

JAMES G. ZOBIAN, chairman of the science department of Roslyn High School, New York, and president of the Science Teachers' Association of New York State, has received the \$1000 Nichols Foundation Chemistry Teacher Award for 1959. The presentation took place at the annual meeting of the American Chemical Society's New York section.

STANLEY B. FRACKER, retired scientist of the U.S. Department of Agriculture, has been awarded the German Order of Merit, first class, for outstanding work as secretary to the Committee on German-American Cooperation in agricultural research. The committee arranges German-American student exchanges.

JOHN P. HAGEN, former chief of the Vanguard Division of the National Aeronautics and Space Administration, has been appointed assistant director for program coordination. ARNOLD K. BALLS, professor emeritus of biochemistry at Purdue University, received the McCollum Award at a dinner during the recent annual meeting of the American Society of Biological Chemists. The \$1000 award is made in recognition of research work in biochemistry carried out after the age of 60.

Scientific visitors to the United States from the United Kingdom are as follows:

G. A. W. FRANCE, experimental officer, Department of Scientific and Industrial Research, London, arrived on 23 April for about 16 weeks. He will spend 12 weeks at the University of California and 2 weeks at other universities.

L. GRUNBERG, senior principal scientific officer and acting head of the Lubrication and Wear Division, Mechanical Engineering Research Laboratory, Glasgow, Scotland, will arrive on 20 May. He will attend the 5th World Petroleum Congress in New York 30 May–5 June. Itinerary: Tennessee, Illinois, New York, Massachusetts, and Washington, D.C. (20–24 May).

J. F. MARTIN, principal scientific officer, National Chemical Laboratory, Teddington, arrived on 1 May for about 9 weeks. He will spend 1 month as a member of a team engaged in the study of specific heat calorimetry at the thermodynamics laboratory of the U.S. Bureau of Mines in Oklahoma, and 2 weeks at the thermal laboratory of the Dow Chemical Company in Midland, Michigan.

RICHARD E. HORNER, assistant secretary of the Air Force for research and development, has resigned, effective 1 June to accept the newly established position of associate administrator of the National Aeronautics and Space Administration.

BERNARD L. HORECKER, formerly chief of the laboratory of biochemistry and metabolism, National Institute of Arthritis and Metabolic Diseases, Bethesda, Md., has been appointed professor and chairman of the department of microbiology at New York University's College of Medicine. He succeeds ALWIN M. PAPPENHEIMER, Jr., who has become chairman of tutors in the department of biological chemistry at Harvard University Medical School.

C. S. DRAPER, head of the department of aeronautics and astronautics at Massachusetts Institute of Technology and an inventor of inertial guidance systems for aircraft, missiles, and submarines, has been appointed chairman of the National Inventors Council. He succeeds Charles F. Kettering, who held the post from the establishment of the coun-

cil in 1940 until his death in November 1958. HOMER H. EWING, staff member of Du Pont Company's development department, will serve as secretary.

LEWIS B. SWIFT, chairman of the board of directors of Taylor Instrument Companies, Rochester, N.Y., received the Scientific Apparatus Makers Association Award at the association's 41st annual conference in Chicago, Ill.

#### **Recent Deaths**

FRANK H. BETHELL, Ann Arbor, Mich.; 56; professor of internal medicine at the University of Michigan and director of the Thomas Henry Simpson Institute for Memorial Research; specialist in hematology; 22 Apr.

JOHN J. DONLEAVY, Montclair, N.J.; 63; general consultant in organic chemistry for the research laboratories of the Allied Chemical Corporation's general division; technical director of the division, 1941–51; assistant professor of chemistry at Yale University, 1924–39; 16 Apr.

HÔWARD W. HAGGARD, Fort Lauderdale, Fla.; 71; retired in 1956 as director of Yale University's Laboratory of Applied Physiology; founder of the Center of Alcohol Studies at Yale and editor of the Quarterly Journal of Alcohol Studies; author of a number of popular books, including Devils, Drugs and Doctors, published in 1929; 22 Apr.

GEORGE H. HOXIE, Berkeley, Calif.; 86; specialist on tuberculosis; former dean of the University of Kansas Medical School; 10 Apr.

ERNEST A. JOHNSON, Chicago, Ill.; 64; president of Lake Forest College since 1943; successfully persuaded industrialists to support liberal arts education; a pioneer in the campaign for faculty salary increases; 13 Apr.

WALTER G. RYAN, Nutley, N.J.; 68; director of the guidance center and lecturer in psychology at Seton Hall University since 1951; former chief of the Veterans Administration guidance center at the Newark College of Engineering, where he was associate professor of personnel relations, 1946–51; 22 Apr.

JULIUS SCHUELEIN, New York; 77; chemist and partner in the Vegex Company, New York; pioneer in the development of food products and vitamin preparations derived from brewers' yeast; a native of Germany, he headed companies throughout Europe and, in this country, established facilities for Standard Brands, Inc., for manufacture of the products he developed; 20 Apr.

GUSTAV F. SIEMERS, Montclair, N.J.; 63; technical director of the vitamin division of Hoffmann-La Roche, Inc., for 19 years; 13 Apr.

## Book Reviews

The Mammals of North America. E. Raymond Hall and Keith R. Kelson. Ronald Press, New York, 1959. xxx + 1241 pp. Illus. 2 vols, \$35.

d

1-

ic

es

S

of

9;

rt

ry

d

0-

u-

id

as

0,

ge

IS-

n;

ıl-

nd

ni-

he

er

ıg,

er-

k:

ex

le-

in

st;

m-

nis

d-

he

ir.

ta-

he.

129

It is practically certain that the species of North American mammals are now completely known. Under the influence of man, ranges are still changing, but little more information about natural ranges in early historical times is to be expected. With regard to classification, the principal remaining task is the elimination or lowering in taxonomic rank of a considerable number of supposed species that will almost certainly prove either to be of less than true specific status or to be altogether invalid as taxa at any level. The most important future studies of North American recent mammals will not be classificatory. Almost everything is still to be learned about the actual variation in wild populations of mammals and the real geographic and ecological distribution of such variation-a study that has been as much confused as furthered by the traditional descriptions of subspecies. A somewhat better start has been made on the biological (other than taxonomic) study of North American mammals-of their physiology and behavior and many allied topics-but here, too, the major part of the task is still to be done.

Now, when the era of discovery and classification is closing, it is time to consolidate its data as the required basis for the new era of more broadly biological mammalogy. That is the aim and importance of this enormous work by, among others, Hall and Kelson, This mammoth publication occupies about 285 cubic inches of space and weighs close to 9 pounds. It has 1083 text pages plus 30 introductory and 158 separately numbered index pages. There are 500 distribution maps in the text, two large end-paper maps, and 538 figures of skulls, most of them in three views. There are also, according to the publisher's claim (these figures are unnumbered), 186 life drawings of mammals. Preparation of the book took 12 years, and the work was supported by grants from four sources. Besides the two authors named on the title page, 37 workers are given credit for assistance with the text, ten artists for the illustrations, and eight typists for the manuscript.

'North America," as here defined, runs from Greenland through Panama and also includes the Antilles through Grenada—an enormous area that is not a natural zoogeographical unit. After a prefatory note, the work begins with an all-too-brief discussion of some zoogeographical points. It closes with detailed instructions for inexperienced collectors, which seem somewhat out of place in a publication obviously intended neither for beginners nor for field use. Between these two sections, the great bulk of the study is a systematic treatment of the 3679 recognized basic taxa (subspecies and monotypic species) and the higher categories in which they are arranged. Check lists of the last 35 years have steadily reduced the number of recognized native full species, which stands in this volume at 995. That is still evidently too many, and the authors predict that revision will eventually reduce it to about 800.

This study is not itself a revision. On the contrary, in principle it is a compilation of previously published material with as little new interpretation as possible. It assumes that the last published account of any group based on specimens was correct-even when it obviously was not. The only original data by the present authors are some identifications of specimens for inclusion in the distribution maps, and in making these identifications they have not checked the validity of the taxa to which the specimens are referred. Although the authors do not so state, the over-all classification from genera upward is almost precisely that which I published in 1945. It is not an adverse criticism to note that the authors have aimed at a purely mechanical résumé of previous literature. Such a bibliographically objective compendium is all the more reliable for its avoidance of new personal opinion.

All the taxa recognized above the subspecies are briefly defined or identified, and within each order there are keys for identification of museum specimens down to species. Synonymies, with references, are given for genera and subspecies but not, oddly enough, for species. Brief comments on habits, ecology, or reproduction are made for many species. Standard dimensions are given for species, but a bad habit of mammalogists is inevitably carried over from the primary literature: ranges of measurements are usually given without indication of means, sizes of samples, or differences in range in subspecies or other populations, so that the real nature and limits of the variation are unguessable.

Geographic ranges of subspecies (and monotypic species) are given in the text in terms of marginal records, with references. In most cases geographic distribution is shown on maps as well. with marginal records shown by dots and the inferred total area shaded and numerically keyed. Distributions shown are the maxima justified by any literature and by specimens. They therefore are of varying dates, as is usually made clear in the text. For the bison, for example, the range mapped is approximately that of the period just before America was settled by Europeans, but for the opossum the range is shown as of 1957 and includes areas of recent introduction where opossums never occurred naturally. On the whole these maps are the most valuable contribution of the work. There is no other publication that has so many range maps of such reliable detail.

Some unsatisfactory points in current mammalian systematics are strikingly reflected in the maps, as the authors properly note in the hope that corrections will be made. In map No. 452, for instance, the type localities of 78 "species" of brown and grizzly bears are all listed as if they were valid but with the warning that the majority of them almost certainly are not. Surely all modern mammalogists recognize that these bears represent just one species. In maps Nos. 262-266, the sharply delimited ranges of 213 named subspecies of the pocket gopher Thomomys umbrinus (all of which the authors do consider valid) are shown, but with the comment that every local population in this species is distinctive and that selection of those to be given subspecific names is subjective. The authors' plan left them no choice and required mapping the "subspecies," but the reader will surely feel that the traditional approach to systematics in this group has completely failed to promote biological understanding.

Ît is in line with their aim of mechanical compilation that the authors favor the most rigid application of priority in nomenclature. (Their preface even expresses regret that they have in some cases followed the International Commission and Rules of Nomenclature when under those rules the commission has set aside priority). The most distressing result is that they followed Hersh-

kovitz in using the name Dama (for generations always applied to distinctive Old World deer) for the American deer that everyone else calls Odocoileus. This compounds confusion and is an obvious case of a situation in which official sanction of the practically universal usage should be sought.

At just one or two points the authors have injected personal views, and the result is not always happy. The worst example is a passage, initialed "E.R.H.," which seeks to justify inclusion of gibbons and apes in the Hominidae. "E.R.H." argues that previous family separation was made "because of an assumed wide gap in intelligence," which is at best an inadequate statement of the case. He then expresses the astonishing opinion that "the gap in intelligence between some microgeographic races of man and some races of apes is . . . no wider than that between genera in some other families, for example, that between the two genera Canis and Dusicyon of the family Canidae." This is only one spot in a large work, but it is too egregious to be passed over in silence.

In view of some advertising for which the authors are not responsible, general students and nonprofessional readers should be advised that their purposes will almost certainly be better served by any of several less expensive books on North American mammals. For its own properly intended audience, the professional mammalogists, this publication truly deserves the frequently misused adjective *indispensable*. Henceforth no one can work at the technical level in this field without reference to Hall and Kelson.

G. G. SIMPSON American Museum of Natural History and Columbia University

Fundamentals of Ecology. Eugene P. Odum. Saunders, Philadelphia, 1959. xviii + 546 pp. Illus. \$7.50.

The popularity of this well-written text is attested to by this thoroughly revised and enlarged second edition, which appears less than six years after publication of the first edition. The "statementexplanation-example" treatment of principles has been retained.

The three parts, "Basic ecological principles and concepts," "The habitat approach," and "Applied ecology," have been enlarged by 74, 14, and 41 pages, respectively. There are 41 additional figures. Much of the text has been rewritten to incorporate more recent thinking.

As in the first edition, the ecosystem approach is emphasized. Most of the sections have been enlarged, in particular those on the ecosystem, energy rela-

tions, the biotic community, and phytosociology. Some new sections have been added, such as those on biogeochemical cycles and ecological indicators. The new chapter on radiation ecology is comprehensive, clear, and most important at this time.

I have a few—perhaps trivial—criticisms: The extensive use of exclamation points may be somewhat irritating to some readers; the useful term *stand* has apparently been omitted; the "sand sage grassland community" occurs more widely than is stated on page 27; and the section on phytosociology is very brief.

The science of ecology has been criticized, often unjustly, for cumbersome terminology. In this book the meaning of concepts is not lost in unnecessary, abstruse words. Commendable, also, is the procedure of precisely defining words that are used widely in a general sense to explain their meaning in a more specific ecological sense—for example, community, competition, and population.

Herbert C. Hanson Department of Biology, Catholic University of America

Physics of Meteor Flight in the Atmosphere. Ernst J. Opik. Interscience, New York, 1958. viii + 174 pp. Illus. Cloth, \$3.85; paper, \$1.95.

The title clearly defines the scope of this book. By treating only the physical phenomena associated with the flight of high-speed objects through the earth's upper atmosphere, the author has been able to present an exhaustive, theoretical treatise covering most of the possible combinations of circumstances involved in this problem. The main purpose of the physical theory of meteors is "to predict the variation of mass, velocity, luminosity, and ionization along the meteor trajectory."

In the first three chapters the author provides the necessary introductory material by (i) defining the problem, (ii) briefly describing the characteristics of those regions of the upper atmosphere in which meteoric phenomena take place, and (iii) classifying and describing meteoric particles and phenomena. The primary divisions in the theoretical problem are made on the basis of whether the molecular mean free path in the upper atmosphere is large or small as compared with the size of the meteoric particle, and whether the particle is solid iron, solid stone, or a "dustball" skeleton of cosmic dust.

In the next three chapters the details of energy transfer, particle dynamics, and ablation are presented. The large number of possible processes at work in the disintegration of the various meteoric particles is treated efficiently by the author, with the aid of a very large number of tables. In chapters 7 and 8, the formation of heat, light, and ionization in the coma near the particle and in its wake is described. The final chapter, "Some applications," treats briefly the "dustball" characteristics of certain sporadic and shower meteors.

Opik is well known for his extensive theoretical and experimental work on meteoric phenomena over the past 37 years. He writes with considerable authority on this subject. There is some tendency, however, to state as fact certain interpretations upon which there is

no general agreement.

Meteoric phenomena not treated in this monograph include the astronomical characteristics of meteors and the physics and applications of radio reflections from meteor trails. In staying within the intended scope of this book, the author could not of course survey the extensive literature on radio detection of meteors. However, the results of some of these studies are applicable to his theoretical models-for example, the radio studies of trail diffusion, the size of the rapidly formed coma, particle deceleration, and turbulence. The author also treats only slightly the results of photographic studies of meteors and refers mainly to the earlier visual studies. Little or no specific mention is made of the application of meteoric phenomena to upper-atmosphere studies, radio communication, space-vehicle hazards, and ballistic vehicle reentry. However, the author has certainly been successful in his announced intention of providing a basis for further research on the physical theory of meteors.

VON R. ESHLEMAN

School of Engineering, Stanford University

Science Students' Guide to the German Language. A. F. Cunningham. Oxford University Press, London, 1958. xiii + 186 pp. \$2.

This guide, although well printed, carefully worked out, and with many individual excellences, will probably not be of much assistance to Americans who are impelled to study German. The chapters are not organized to provide an orderly pedagogical progression into the grammar. Chapter 4, "Declension of nouns," treats only the singular inflection (one and a half pages) and includes no exercises; chapter 7, "Verbs" (ten pages, including exercises), lists the forms of 117 strong verbs and devotes a half page to detailed discussion of the

distinction between the weak and strong participles of salzen and spalten. On the other hand the chapters do not provide a complete treatment of a given gram-

matical category.

)-

n

e

7

e

al

s-

ıs

ie

r

re

s.

al

28

y

y

n

6-

1-

al

N

ın

d

d,

n-

ot

10

ne

n

ne

of

c-

es

en

he

he

29

Grammatical exposition follows the traditional pattern, but many of the statements are so casual as to be misleading. Such statements as the following would find little favor with either traditionalists or with "modernists": "The Glottal Stop is the name given to a pause before a German word or syllable beginning with a vowel" (page 1); "In German, as in English, there are only three simple tenses, the Present, Past, and Imperative" (page 12); "All intransitive verbs of motion . . . are conjugated with 'sein'" (page 14).

The 80 pages of German selections, each running to approximately 350 words, seem to me well chosen. The physical sciences dominate this section, however; in 11 pages on bacteriology Cunningham gives a nod to biology.

GEORGE J. METCALF

Department of Germanic Languages and Literatures, University of Chicago

Biological and Biochemical Bases of Behavior. Harry F. Harlow and Clinton N. Woolsey, Eds. University of Wisconsin Press, Madison, 1958. xx + 476 pp. Illus. + plates. \$8.

This volume, dealing with a symposium held at the University of Wisconsin over three years ago, is more representative of what went into than of what came out of the meeting. The initial papers are presented, some attention is given to the other contributions, and there has been some updating through the inclusion of new references and findings, but the actual exchange that took place at the meeting has, unfortunately, been omitted. The result is a group of 17 chapters, by thoughtful and experienced men in a variety of fields, which run the gamut from moderately detailed reports of an individual's current research, through presentations that epitomize fairly completely the author's work and viewpoint, to broad and penetrating studies that grapple with the fundamental problems of biology and behavior. Incidentally, since "biochemical" is really included in "biological" to the same extent that "physiological" or "anatomical" or "embryological" are, and since only a couple of the articles consider the chemical factors involved, inclusion of biochemical in the title gives a slight distortion in emphasis-especially since much important work in the area of biochemistry has been omitted.

Despite such limitations, the volume is an admirable contribution to the growing rapprochement in studies of brain and behavior. The authors have written frankly, often self-critically, of themselves and their disciplines; most of them had clearly in mind the objective of arriving at an interdisciplinary understanding (some express marked reservations concerning the effectiveness of interdisciplinary teams in achieving this), and they have brought a wealth of experience and accomplishment to bear on the problems.

Many of the reports are indeed interdisciplinary in that the experiments involve a combination of behavioral and other biological techniques. In accord with the historical development in this area, the correlations are still overwhelmingly between behavior and anatomy, whether such correlations are determined by sectioning and staining or by locating electrical pulses with penetrating electrodes-a technique which Neff and Diamond often find more valuable. But the physiological properties of neurones and their connections may be more important than their locus, and the character of neural events more critical than their site. It is a pleasure to find a psychologist with the courage to eschew bondage to anatomical detail, as does Donald Meyer, in the face of overcommitment to serial sections on the part of so many workers. Perhaps the most completely formulated attack on the problem of anatomical patterns versus physiological states, and of specific connections versus global influences, is given by Roger Sperry in the excellent chapter on plasticity of the nervous system; but many other authors deal with parts of this problem and contribute important facts and interpreta-

Donald Hebb in his summarizing chapter, "Alice in Wonderland, or psychology among the biological sciences," writes with his usual verve and courage. After giving a good thumbnail sketch of the history of psychological thoughtfashions (and aiming some good shillelagh blows at contemporaries who neglect the contents of the skull, on the one hand, or the actual performance of the organism, on the other), he takes a thoroughly sound position on the validity of studying phenomena at each level, from the molecular to the organismic or social. I do think Hebb is unduly pessimistic about the application of neurophysiological models to the explanation of behavioral phenomena (my own models are clearly superior to those he seems to be discussing!), but I forgive him for this, because he is so right on other points. He criticizes advisedly the trend toward straight-jacket training of graduate psychology students-apparent especially in the requirement that they "formulate an hypothesis," "design an experiment," and take a course on "how to do research" before they are turned loose in the laboratory.

The really heartening aspect of this volume is that such conferences are being held-that workers are crossing disciplinary lines, first to talk with one another and eventually to work together, even if they do not become masters of all trades or committed to membership in interdisciplinary teams. These are precious beginnings, the rivulets from which will rise great streams of research and application in behavioral science.

R. W. GERARD Mental Health Research Institute, University of Michigan

Nouveau traité de chimie minérale. vol. 11, group V, Arsenic, antimoine, bismuth. xxxix + 850 pp. Illus. 1958. Cloth, F. 8950; paper, F. 7750. vol. 14, group VI, Chrome, complexes du chrome, molybdène, tungstène, hétéropolyacides. xxxix + 1014 pp. Illus. 1959. Cloth, F. 10,700; paper, F. 9500. Paul Pascal, Ed. Masson, Paris.

A review of volumes 1 and 10 of this work appeared in Science of 1 March 1957 [125, 401 (1957)]; that of volume 3, in the 18 July 1958 issue [128, 138 1958)]; and that of volume 4, in the 6 March 1959 issue [129, 636 (1959)].

Volumes 11 and 14 follow the format of the previously published volumes of this modern treatise on inorganic chemistry. It is expected that the entire treatise, consisting of 20 volumes, will be completed by 1960.

RALEIGH GILCHRIST

Division of Chemistry, National Bureau of Standards

Mineralogy and Geology of Radioactive Raw Materials. E. William Heinrich. McGraw-Hill, New York, 1958. xiv + 654 pp. Illus. \$14.50.

This book, which offers an encyclopedic coverage of the vast literature concerned with radioactive raw materials, is particularly timely. It is the first of the books that have been published in this field to give an adequate and intelligent résumé of the mineralogy and geology of this important commodity. It will be especially useful for general reference and source material. The coverage of significant source data is nearly complete, and in general a good selection has been made of the evidence and interpretation presented by the original authors. Some bias is evident,

however, in Heinrich's selection of statements favoring his own classification and

genetic concepts.

The book is a particularly welcome contribution from the standpoint of the mineralogy (the author's forte) of uranium deposits. The application of data on mineralogic characteristics and geochemical relations to the habits of the deposits and to genetic concepts are developed to some extent, though perhaps one might have expected a more extended treatment.

The author focuses attention on the problems of classification by reviewing in considerable detail previous schemes. He brings to light, through careful reviews, the many conflicting genetic concepts, but more rationalization and development of the evidence are needed in support of his own firm classification. Many readers will still be reluctant, as the author points out, to accept this classification. Most workers have had difficulty with the classification of the "so-called Colorado Plateau type" deposits or "sandstone type" deposits. Heinrich introduces new terminology, "Epigenetic Stratiform deposits in sedimentary rocks," for these deposits, but after the introduction of the term in chapter 10, he fails to use it again in the chapter.

The frequent insertion of references in the text indicates that Heinrich was fully conscious of his obligations to the authors of the source material, but this style of writing often detracts from the readability of the book. The reader's interest might be better sustained had the evidence been predigested to a greater extent, and had the references been

more generalized.

The exceptionally long and carefully selected bibliography is an important part of the book and should be of great value as a ready reference for students

of these deposits.

The author is to be congratulated for having undertaken and completed the task of compiling the formidable literature on this subject into a book such as this. It is sure to become a best seller in this field.

A. L. BROKAW

185 Estes Street, Denver, Colorado

The Ecology of Human Disease. Jacques M. May. MD Publications, New York, 1959. xxi + 327 pp. Illus. \$7.50.

Ecology, the study of the interrelationships between organisms and their environment, will continue to be of increasing importance in the future advances of medicine. In this first volume of a threevolume work, Jacques May has assembled much interesting information that will prove to be useful as a starting point for further studies in this field.

As a definitive work on ecology of disease, however, I am of the opinion that it falls short of its mark, Perhaps the chief reason for this is that May has tried to extend our limited knowledge on a world basis. As a result, incomplete or dubious information for much of the globe is often compared with better data for the few restricted locations for which the information is more definite.

The compilation thus appears to be sketchy and drawn in such broad strokes that the specific contribution of the ecologic approach often is obscured. In fact, a passage of two pages (pages 30-32) on a more specific situation studied by the author in Viet Nam is much more revealing of ecology as I understand it than most of the remaining 320 pages of the book.

The foreword (11 pages) by Marti-Ibañez sets some sort of standard as an exercise in hyperbole and historical name-dropping.

MICHAEL B. SHIMKIN

National Cancer Institute, National Institutes of Health

#### New Books

De l'Actinie à l'homme. Études de psychophysiologie comparée. vol. II, De l'Instinct animal au psychisme humain affec-tivité et conditionnement. Henri Pieron. Presses Universitaires de France, Paris, 1959. 264 pp.

Alcohol in Italian Culture. Food and wine in relation to sobriety among Italians and Italian Americans. Giorgio Lolli, Emidio Serianni, Grace M. Golder, Pierpaolo Luzzatto-Fegiz. Free Press, Glencoe, Ill.; Yale Center of Alcohol Studies, New Haven, Conn., 1959. 155 pp. \$4.

Antonio Meucci, Inventor of the Telephone. Giovanni E. Schiavo. Vigo Press,

New York, 1958. 288 pp. \$10.

Area and Power. A theory of local government. Arthur Maas, Ed. Free Press, Glencoe, Ill., 1959. 224 pp. \$5.

Australian Road Practice. An introduction to highway engineering. H. M. Sherrard. Melbourne Univ. Press, Melbourne, Australia; Cambridge Univ. Press, New York, 1958, 430 pp. \$19.50.

The Bases of Speech. Giles Wilkeson Gray and Claude Merton Wise. Harper, New York, ed. 3, 1959. 575 pp. \$6.

Cell and Tissue Culture. John Paul. Livingston, Edinburgh; Williams & Wilkins, Baltimore, Md., 1959. 269 pp. \$7. Child Development. Willard C. Olson.

Heath, Boston, ed. 2, 1959. 508 pp. \$6.25. Classical Mechanics. J. W. Leech. Methuen, London; Wiley, New York, 1958, 158 pp. \$2.50.

Clay and Clay Minerals. Proceedings of the Sixth National Conference on Clays and Clay Minerals. Monogr. No. 2. Ada

Swineford, Ed. Pergamon, New York, 1959. 422 pp. \$8.50.

Cryogenic Engineering, Russell B. Scott. Van Nostrand, Princeton, N.J., 1959. 379 pp. \$5.60.

Dictionary of Education. Prepared under the auspices of Phi Delta Kappa. York, ed. 2, 1959. 703 pp. \$9.75.

Diseases of Laboratory Primates. Theo-

dore C. Ruch. Saunders, Philadelphia,

1959. 621 pp.

EDTA Titrations. An introduction to theory and practice. H. A. Flaschka. Pergamon, New York, 1959. 138 pp. \$6.50.

The Effect of Pharmacologic Agents on the Nervous System. Proceedings of the Assoc, for Research in Nervous and Mental Disease, vol. 37. Francis J. Braceland. Ed. Williams & Wilkins, Baltimore, Md., 1959. 499 pp. \$13.50.

Endocrine Control in Crustaceans. David B. Carlisle and Francis Knowles. Cambridge Univ. Press, New York, 1959.

127 pp. \$3.75.

Exchange of Genetic Material: Mechanisms and Consequences. vol. 23, Cold Spring Harbor Symposia on Quantitative Biology. Biological Laboratory, Cold Spring Harbor, N.Y., 1958. 449 pp. \$8.

Filler Metals for Joining. Orville T.

Barnett. Reinhold, New York; Chapman & Hall, London, 1959. 253 pp. \$7.

Fringe Benefits. Francis M. Wistert. Reinhold, New York; Chapman & Hall, London, 1959. 155 pp. \$3.75.

The Higher Terpenoids. P. de Mayo. Interscience, New York, 1959. 246 pp. \$6.

Historical Geography of the North Carolina Outer Banks. Gary S. Dunbar. Louis-

iana State Univ. Press, Baton Rouge, 1959. 246 pp.

The Life and Letters of Charles Darwin. Including an autobiographical chapter. Edited by his son, Francis Darwin; foreword by George Gaylord Simpson.
vols. 1 and 2. Basic Books, New York,
1959. 570 pp.; 571 pp. 2 vols., \$10.
Principles of Modern Physics. Robert

B. Leighton. McGraw-Hill, New York,

1959. 807 pp. \$7.50.

Protection in Diagnostic Radiology. B. P. Sonnenblick. Rutgers Univ. Press, New Brunswick, N.J., 1959. 376 pp. \$7.50.

Psychopharmacology. Problems in evaluation. Proceedings of a conference sponsored by National Institute of Mental Health, National Academy of Sciences-National Research Council, and American Psychiatric Association. Publ. No. 583. Jonathan O. Cole and Ralph W. Gerard, Eds. National Acad. of Sciences, Washington, D.C., 1959. 679 pp. \$6.50.

Radiographic Atlas of Skeletal Development of the Hand and Wrist. William Walter Greulich and S. Idell Pyle. Stanford Univ. Press, Stanford, Calif.; Oxford Univ. Press, London, ed. 2, 1959. 272

pp. \$15.

Semiconductors. N. B. Nannay. Reinhold, New York; Chapman & Hall, London, 1959. 790 pp. \$15.

Six-Membered Heterocyclic Nitrogen Compounds with Three Condensed Rings. C. F. H. Allen. Interscience, New York, 1958. 646 pp. \$26.

## Reports

#### Population Size Required for **Investigating Threshold Dose in** Radiation-Induced Leukemia

Abstract. Studies of leukemia in populations receiving small amounts of radiation are needed to investigate the question of a threshold dose. Estimates have been made of the population sizes required to detect a statistically significant increment of leukemia at specified low exposures, by means of the dose-response relation observed by Court-Brown and Doll at high

The leukemogenic effect of large doses of ionizing radiation is now well established. A problem which remains unsolved is whether there exists a threshold dose of radiation below which leukemia is not induced

Various studies of populations exposed to low doses of radiation have been proposed to settle this question, including a comparison of populations living at high and low altitudes. At an altitude of 6000 feet, the annual excess of cosmic radiation over that received at sea level is approximately 23 mr, or 1.5 r by age 65. I attempted to examine leukemia death rates by altitude in the United States, only to realize that it was extremely unlikely that the effect of such a small dose, even if it existed, could be demonstrated as statistically significant with the sizes of populations available. This realization led to an attempt to estimate what population sizes would be required to demonstrate significant leukemogenic effects of small doses of radiation.

For this purpose, the dose-response data of Court-Brown and Doll (1) were used. Over a dose range of approximately 500 to 2000 r. Court-Brown and Doll observed a linear relationship such that the annual incidence of leukemia per 100,000 population is increased by 4.9 cases per dose of 94 r to the spinal marrow. The equivalent whole-body dose is estimated by them to be between 30 and 50 r. By taking their upper estimate, this dose-response relationship can be extrapolated and expressed as follows: for each roentgen unit received as a wholebody dose, the annual death rate from leukemia per 100,000 population would be increased by 0.10 (for leukemia, death rate and case rate can be equated).

This relationship was then applied to hypothetical populations receiving specified whole-body doses of radiation from birth to age 34, and followed for 10 years from age 35 to 44 years. In making the calculations, two assumptions were invoked: i) that if deaths from radiationinduced disease resulted from that part of the dose received before age 35, such deaths would not occur selectively, and thus the population remaining at age 35 would have the same dose-response rate as the original cohort; ii) that, for ease of calculation, general mortality between ages 35 and 44 could be neglected. This is a reasonable assumption since mortality loss over this 10-year age span is only about 3 percent (2).

For each dose of radiation, the leukemia deaths predicted from Court-Brown and Doll's dose-response rate were taken for populations of decreasing size, until the difference between this hypothetical "observed" number of deaths and the number expected from general population rates failed to reach statistical significance at the 5-percent level. The general population rate used was that given by MacMahon (3) for the United States population aged 35 to 44 from 1949 to 1953 (3.32 per 100,-000). Statistical significance of the difference between an "observed" and expected number of deaths was based on

Poisson variable (4). Table 1 gives, for doses ranging from 5 to 200 r, the minimum population size which on the average would reveal a significant effect. Population size is expressed in person-years-for example, for

confidence limits for the expectation of

5 r, 6 million persons followed for 1 year or 600,000 followed for 10 years are required.

It is now of interest to relate these estimates to completed and proposed studies of the threshold question. The unique exposure of a population of 100,-000 persons living in a radioactive monazite sand area in the state of Travancore. India, is a case in point. The dose received over a 30-year period is said to lie between 10 and 30 r (5). The estimates shown in Table 1 indicate that it should be possible with a population of this size to demonstrate, statistically, a leukemogenic effect of 30 r, if such exists. However, these estimates can be applied to the Travancore situation only if age-specific leukemia mortality rates of the Indian general population are comparable to those in the United States and if leukemia is diagnosed as adequately there as it is in the United States. The latter requirement presumably could be met if a special study were made of the Travancore inhabitants and of a sizable Indian control population.

Court-Brown and Doll (6) have published a study of the mortality of 1377 British radiologists from 1897 to 1957. For the 10,279 person-years of risk among radiologists who began practice before 1921, when less care was taken to prevent exposure to x-rays, the excess of observed leukemia deaths over the expected number did not reach statistical significance. The average total dose received by the group obviously cannot be determined, but if it were just short of 200 r, the available population size would not be quite sufficient to permit detection of a statistically significant excess of leukemia deaths. Moreover, the estimates given in Table 1 refer to exposures from birth to age 34, which is not the situation among radiologists. If dose-response rate does not rise with age, the sizes of the required populations would be greater for exposures occurring at an older age, since leukemia mortality among adults increases with age.

The possibility that dose-response rate may actually fall with age is suggested by the observation of Stewart et al. (7)

Table 1. Minimum population sizes for specified doses of radiation.

Dose from birth to age 34 (r)	Minimum person-years at ages 35 to 44
5	6,000,000
10	1,600,000
15	750,000
20	500,000
50	100,000
100	30,000
200	10,000

d

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should not repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the

Type manuscripts double-spaced and submit one

Type mattacting action copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references

Limit illustrative material to one 2-column figure (that is, a figure whose width equals two col-umns of text) or to one 2-column table or to two Incolumn illustrations, which may consist of two figures or two tables or one of each. For further details see "Suggestions to Contrib-

utors" [Science 125, 16 (1957)].

that mothers of children dying from leukemia had a significantly greater frequency of antenatal abdominal x-ray examinations than mothers of matched control children (13 percent compared with 7 percent). The x-ray dosage in this type of examination would not exceed 5 r. It is apparent that such a large difference between the two groups of children would not be found if the dose-response relationship in the fetus were that estimated for adults by Court-Brown and Doll. This leads one to estimate from Stewart's data the fetal dose-response which would produce such a difference.

1) The estimated population under age 10 in England and Wales in 1951 was 6 million. If the percentage of mothers of control children reporting an antenatal x-ray (7 percent) is applied to this population, there would be an estimated 420,000 children exposed in utero to a dose of approximately 5 r and 5.58 million children not so exposed.

This was done as follows:

2) From 1953 to 1955 there were 792 leukemia deaths in this age group, an annual average of 264.

3) Let  $R_1$  and  $R_2$  be the annual leukemia death rates per 100,000 population under age 10, for children with and without antenatal irradiation, respectively.

4) Since 13 percent of the leukemia children had a history of antenatal x-ray, 34 (0.13 × 264) children dying of leukemia in one year would have such a history. Therefore

$$R_1 = \frac{34 \times 100,000}{420,000} = 8.1$$

5) Since the remaining 87 percent of the 264 leukemia deaths would come from the nonirradiated group,

$$R_s = \frac{230 \times 100,000}{5,580,000} = 4.1$$

6) Thus an estimated annual increment of 4.0 deaths per 100,000 population followed a dose of 5 r. The increment expected from Court-Brown and Doll's dose-response data is only 0.5 per 100,000.

Thus it appears that if Stewart's observation does, in fact, reflect an association between antenatal irradiation and leukemia, the response rate of embryonic tissue is approximately 8 times that of adult tissue.

The estimates which form the basis of this report are not intended to be precise figures, but are offered merely to stimulate interest in a very practical aspect of the problem of investigating the existence of a threshold leukemogenic dose of radiation. This aspect of the problem has so far received little attention.

CAROL BUCK

Faculty of Medicine, University of Western Ontario, London, Canada

1. W. M. Court-Brown and R. Doll, Med. Research Council (Brit.) Spec. Rept. Ser. No. 295 (1957). U.S.A. Life Tables (1955). B. MacMahon, Public Health Repts. 72, 39

Biometrika Tables for Statisticians (Cambridge University Press, Cambridge, 1954), vol. 1, Table 40

Table 40.

A. R. Gopal-Ayengar, in Effect of Radiation on Human Heredity (World Health Organization, Geneva, Switzerland, 1957).

W. M. Court-Brown and R. Doll, Brit. Med. J. 1958II, 181 (1958).

A. Stewart, J. Webb, D. Hewitt, ibid. 1958I, 1495 (1958).

19 December 1958

#### Nitrogen Partition in Excreta of Three Species of Mosquitoes

Abstract. Adults of three species of mosquitoes, Aedes aegypti, Anopheles quadrimaculatus and Culex pipiens, showed essentially similar patterns of nitrogen output as judged by their excretion of total nitrogen and by their excretion of nitrogen as uric acid, urea, ammonia, amino acid, and protein. About 80 percent of their total nitrogen has been accounted for. Substances that seem on analysis to be like glycoprotein have been found in the excreta of the three species.

In continuing our previous work on the total nitrogen and uric acid patterns in the excreta and body tissues of adult Aedes aegypti (1) we have further partitioned the nitrogen excretion and have extended the analysis to two other species of mosquitoes, Anopheles quadrimaculatus and Culex pipiens.

The methods for the collection and extraction of mosquito excreta and lyophilization of the extracts were essentially similar to those employed in previous work (1). All analyses were performed in duplicate on extracts (lyophilized dry solid form) of excreta collected for a period of 2 weeks from insects on a diet of 4 percent sucrose and without any source of nitrogen. Total nitrogen was determined by the Kieldahl method, and uric acid nitrogen was determined by the method of Kalckar (2) as modified by Praetorius (3). Urea and ammonia nitrogen were determined by the method of Seligson and Seligson (4).

The amino acid nitrogen determination was performed on desalted material as follows. A weighed amount of excreta (20 to 50 mg) was dissolved in 25 to 50 ml of distilled water and passed through a column (1 by 4 cm) of Dowex-50 (X-4, 50 to 100 mesh) in the hydrogen form. The column was washed with distilled water until the washings were neutral. The amino acids were eluted with 14 percent ammonia. The excess ammonia was removed in a vacuum at 25°C, and the solution was lyophilized. Amino acid nitrogen was determined by the Ninhydrin method of Moore and Stein (5) on a portion of the lyophilized material after the solids had been dissolved in a measured volume of distilled water.

Protein nitrogen was determined as follows. A weighed amount of the dried excreta extract (30 to 100 mg) was dissolved in a minimum volume of water, placed in a cellophane bag, and dialyzed for 3 days at +2°C against several changes of water. The dialyzed material was evaporated to dryness and hydrolyzed with 6N HCl at 110°C for 18 to 24 hours. The hydrolyzate, after removal of the HCl in a vacuum, was diluted to a convenient volume, and the amino acid nitrogen was determined by the Ninhydrin method (5).

Table 1 shows that the three species of mosquitoes, Aedes aegypti, Anopheles quadrimaculatus and Culex pipiens have essentially similar patterns of nitrogen excretion. Uric acid N represents approximately half of the total N, urea N about 10 percent, ammonia N about 10 percent, amino acid N about 5 percent, and protein nitrogen about 10 percent. Thus 80 percent of the total N excreted is accounted for.

Paper chromatography (6) was also performed on the protein hydrolyzates. The results showed the presence of tyrosine, phenylalanine, leucine, isoleucine, valine, proline, alanine, threonine, glycine, serine, glutamic acid, aspartic acid, arginine, lysine, cysteic acid, galactosamine, glucosamine, and trace amounts of β-alanine, indicating that the nondialyzable material probably contained a glycoprotein. This material was likewise found in the excreta of Aedes aegypti during the third and fourth

Table 1. Nitrogen partition in mosquito excreta collected for 2 weeks from mosquitoes on a diet of 4 percent sucrose.

	Nitrogen (%)					Total
Species	Uric acid	Urea	NH <sub>3</sub>	Pro- tein*	Amino acid	nitrogen accounted for (%)
Aedes aegypti	47.30	11.90	6.40	10.82	4.40	80.82
Anopheles quadrimaculatus	42.50	9.50	7.80	9.22	4.70	73.72
Culex pipiens	46.90	7.90	10.00	9.67	5.50	79.97

<sup>\*</sup> Since chromatograms of the protein hydrolyzates indicated the presence of hexoseamines, the protein N values include amine N.

weeks. No analyses were made for the other two species beyond the second week. Work is now under way to isolate and characterize this material. As judged visually from the chromatograms, there were quantitative differences in the composition of the protein hydrolyzates. For instance, tyrosine and phenylalanine were present only in faint traces in Aedes aegypti as compared with higher concentrations in Anopheles and Culex.

> F. IRREVERRE LEVON A. TERZIAN

National Institute of Arthritis and Metabolic Diseases, and Naval Medical Research Institute, Bethesda, Maryland

#### References and Notes

L. A. Terzian, F. Irreverre, N. Stahler. J. Insect Physiol. 1, 221 (1957).
 H. M. Kalckar, J. Biol. Chem. 167, 429 (1947).
 E. Praetorius, J. Clin. and Lab. Invest. 1, 222 (1949). The uricase used was obtained from

(1949). The uricase used was obtained from the Worthington Biochemical Corporation.

D. Seligson and H. Seligson, J. Lab. Clin. Med. 38, 324 (1951). We are grateful to Dr. Sidney S. Chernick, National Institutes of Health, for the microanalyses of urea and ammonia.

S. Moore and W. H. Stein, J. Biol. Chem. 211, 402 (1954).

907 (1954).

907 (1994). F. Irreverre and W. Martin, Anal. Chem. 26, 257 (1954); K. A. Piez, F. Irreverre, H. L. Wolff, J. Biol. Chem. 223, 687 (1956).

24 November 1958

1-

ı.

d d

d

d

S-

d

al

0-

al

id

es

ve

10

ıt,

ed

·O-

ie,

ly-

id,

os-

nts

he

n-

as

les

rth

en ted

N

#### The Clock Paradox

Abstract. In two-dimensional Minkowski space a geodesic arc is longer than every other admissible arc with the same end points. Thus a particle whose worldline is a geodesic-that is, an unaccelerated particle-requires more (local) time to travel between two events than an accelerated particle. Similar results in fourdimensional Minkowski space can be es-

The so-called "clock paradox" (1) in Special Relativity may be loosely stated by saying that if a space traveler were to take an extended trip into space, he would find upon returning to earth that he was younger than he would have been if he had remained at home. Since there is no such concept in Relativity as the same place at two different times, it is clear that a more precise formulation of the problem is required.

To simplify the problem, let us consider it in a space of one time dimension and one space dimension, and let the units be so chosen that the velocity of light is 1. In this two-dimensional Minkowski space, the element of local time is the element of arc length

$$ds = (dt^2 - dx^2)^{\frac{1}{6}}$$

The clock paradox is a simple problem in the calculus of variations.

Let  $P_1$   $(t_1, x_1)$  and  $P_2$   $(t_2, x_2)$  be two events, or points in Minkowski space,  $t_2 > t_1$ . The length of arc between  $P_1$ 

and  $P_2$  along a curve x = f(t) connecting the two points is given by the line integral

$$s = \int_{t_1}^{t_8} (1 - f^2)^{\frac{1}{2}} dt$$

The clock problem consists in comparing arc lengths between P1 and P2 along dif-

The extremals of arc length, or geodesics, are given by the solutions of the well-known Euler equations

$$\frac{\partial \theta}{\partial f} - \frac{\mathbf{d}}{\mathbf{d}t} \left( \frac{\partial \theta}{\partial f'} \right) = 0$$

where  $\theta = (1 - f'^2)^{\frac{1}{2}}$ , and are readily found to be of the form

$$x = f(t) = at + b,$$

where -1 < a < 1. This is a straight line in Minkowski space and represents uniform motion in a straight line in ordinary space. Since Euler's equations are invariant under Lorentz transformations, the concept of geodesic is absolute.

Now comes the crucial difference between geodesics in Euclidean space and geodesics in Minkowski space, a difference which points up the danger of attempting to apply geometric intuition to this problem: In Minkowski space, the extremals (geodesics) represent relative maxima.

To show this, let

$$x = f(t) = at + b$$

be a geodesic connecting  $P_1(t_1, x_1)$  and  $P_2(t_2, x_2), t_2 > t_1$ , and let  $\omega(t)$  be an admissible function vanishing at  $t_1$  and t2, so that

$$x = f(t) + \omega(t)$$

is a neighboring arc to the geodesic. The arc lengths along the geodesic and the neighboring arc are, respectively,

$$s = \int_{t_1}^{t_2} (1 - f'^2)^{3/6} dt$$

$$s + \Delta s = \int_{t_1}^{t_2} [1 - (f' + \omega')^2]^{3/6} dt$$

By the Mean Value Theorem

$$[1-(f'+\omega')^2]^{\frac{1}{16}}=(1-f'^2)^{\frac{1}{16}}+$$

$$\frac{-f'}{(1-f'^2)^{\frac{1}{16}}} \omega' + \frac{1}{2} \frac{-1}{[1-(f'+\phi\omega')^2]^{3/8}} \omega'^{2}$$

where  $0 < \phi < 1$ . Now if f(t) = at + band -1 < a < 1.

$$\int_{t_1}^{t_2} \frac{-f'}{(1-f'^2)^{\frac{1}{16}}} \omega' dt = \frac{-a}{(1-a^2)^{\frac{1}{16}}} [\omega(t_2) - \omega(t_1)] = 0$$
so that

$$\Delta s = -\frac{1}{2} \int_{t_1}^{t_2} \frac{\omega'^8 dt}{\left[1 - (f' + \phi \omega')^2\right]^{3/8}}.$$

The integrand is never negative, and is 0 only when  $\omega(t)$  is a constant and therefore 0. Thus for  $t_2 > t_1$ ,  $\Delta s$  is negative for every neighboring curve. That is, the geodesic x = at + b is an arc along which time is a relative maximum.

Let us assume, then, that we are in a space where there is no gravitation and that the earth is moving with constant velocity in a straight line. Then its world line in Minkowski space is a geodesic. Let  $P_1(t_1, x_1)$  and  $P_2(t_2, x_2), t_2 > t_1$ , be two distinct points on this geodesic. Any other arc connecting  $P_1$  and  $P_2$  would represent the time of another traveler whose motion is, for at least part of the journey, accelerated. This arc will be shorter than the geodesic so that a space traveler leaving the earth at  $P_1$  would indeed be younger when he again met the earth at P2 than he would have been if he had remained at home. C. C. MACDUFFEE

Mathematics Research Center. United States Army, University of Wisconsin, Madison

- For a bibliography, see E. M. McMillan, Science 126, 381 (1957).
- 28 November 1958

#### Carotenogenesis and Resistance of Micrococcus pyogenes to Tetracyclines

Abstract. Although reddish-yellow pigments, mainly 8-carotene and rubixanthine, were present in the original strain of Micrococcus pyogenes var. aureus, mutants highly resistant to tetracyclines were observed to become colorless. All strains lack lipoxidase activity. The colorless strains probably reflect blocking by tetracyclines during carotenogenesis.

When Micrococcus pyogenes var. aureus (Staphylococcus aureus), strain 209 P, was cultured successively in media containing gradually increased amounts of tetracyclines, such as oxytetracycline, chlortetracycline, and tetracycline, acquisition of high resistance to these antibiotics was observed. In contrast to the original strain, which was sensitive to these antibiotics-that is, was killed easily by the antibiotics at a concentration of 0.5 µg/ml-and had a tinge of yellowish color, due to the presence of carotenoid pigments, the resistant strains, which withstood the addition of over 300 µg of tetracycline per milliliter of culture media, were observed to become color-

Both sensitive and resistant strains were grown on nutrient agar containing 2 percent glycerol and adjusted to pH 7.2 for mass cultivation. After incubation for 1 day at 37°C, and then for 6

days at 25°C, the cell crops were collected. The cells were first extracted with methanol and then with freshly distilled ethyl ether free of peroxides. The extracts were mixed up and concentrated under reduced pressure. The residual extract was saponified in 10 percent alcoholic potassium hydroxide solution at room temperature for 10 minutes. The solution was diluted with water and extracts were evaporated to dryness in a vacuum.

The residual mass thus obtained was dissolved in a small amount of petroleum ether (boiling point,  $30^{\circ}$  to  $50^{\circ}\text{C}$ ) and allowed to flow onto columns which consisted of layers of calcium hydroxide and calcium carbonate. By chromatographic separation, only the original strain was ascertained spectrophotometrically to contain  $\delta$ -carotene and rubixanthine (1). The optical densities of the extracts, at wavelengths from 370 to 530 mµ, are shown in Fig. 1.

Each strain highly resistant to tetracycline was colorless, without exception. The lack of color is not attributable to lipoxidase, for it was ascertained, by the linoleic acid method (2), that not only the sensitive strain but also the resistant ones were free of lipoxidase activity.

As is shown in Fig. 1, a strain highly resistant to oxytetracycline has no absorption from 370 to 530 mm after treatment by the same method for extraction

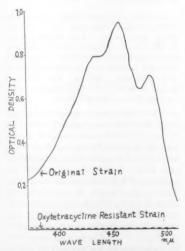


Fig. 1. Optical density versus wavelength for extracts of carotenoids from Micrococcus pyogenes var. aureus 209 P. (Solid line) Original strain; (dashed line) oxytetracycline (300 µg/ml) resistant strain. Solvent, n-hexane; concentration of extract, that obtained from 20 mg (dry weight) of cells per milliliter of n-hexane; instrument used, Beckman spectrophotometer model DU.

of carotenoids as was employed with the sensitive strain.

From these experimental results, it may be suggested that tetracyclines block a step or steps on the pathway of biosynthesis of carotenoids.

GINZABURO SUZUE SHOZO TANAKA

Department of Chemistry, University of Kyoto, Kyoto, Japan

#### References and Notes

- B. Sobin and G. L. Stahly, J. Bacteriol. 44, 265 (1942); J. W. Porter and M. M. Murphey, Arch. Biochem. Biophys. 32, 21 (1951); R. Kuhn and C. Grundmann, Ber. deut. chem. Ges. 67, 339, 1133 (1934).
- Ges. 67, 339, 1133 (1934).
   H. Theorell, S. Bergström, A. Akeson, *Pharm. Acta Helv.* 21, 318 (1946).
- 17 November 1958

#### Half-Life of Sulfur-35

Abstract. A new determination has been made of the half-life of the beta emitter sulfur-35. Approximately 400 measurements were taken over a period of a year and a half. These data were corrected for the dead time of the counter and then treated statistically. The half-life was found to be  $86.35 \pm 0.17$  days.

One of the most commonly used radioisotopes in chemical and biological tracer experiments is S<sup>85</sup>. For accurate work, it is necessary to make a correction for the decay of the isotope; this requires a precise knowledge of the decay rate. The uncertainty associated with the presently accepted half-life of S<sup>85</sup> limits the accuracy of certain types of experiments. Accordingly, we undertook to determine a more precise value for the half-life.

The decay rate  $\lambda$  is defined by the equation

$$\ln N - \ln N_0 = -\lambda t \tag{1}$$

where  $N_0$  is the initial count rate and N is the count rate at time t. It is clear from this equation that if only one radioisotope is present,  $\ln N$  will be a linear function of time. Thus, radioactive contamination of a radioisotope can be detected by a nonlinearity in this relationship. A secondary objective of our experiment was to determine whether such contamination was present.

The S<sup>35</sup> sample was in the form of CaS<sup>35</sup>O<sub>4</sub> deposited on a copper planchet. A thin layer of clear Krylon was placed over the source to prevent the loss of radioactive material.

The planchet containing the source was placed in one of the wells of a shielded, gas flow counter. A C<sup>14</sup> source consisting of a thin plastic film mounted in a planchet was placed in the second well, and the third well was used for background measurements. The C<sup>14</sup> was used as a constant source to check the

efficiency of the counter and insure that it did not change over the period of the experiment. These sources were not touched during the entire experiment, so that each geometry remained the same. The well counter protected the sources from dust which might have absorbed part of the beta radiation, and a visual inspection before and after the experiment indicated that the appearance of the sources had not changed.

Counts were taken at a standard time each day for periods of 10 minutes each on the three wells of the flow counter. Four hundred and one sets of measurements were made over a period of 500 days. During this time the mean background rate was 24 count/min (range, 21 to 27 count/min), and the C14 readings were constant within 1 percent. The initial counting rate of the S35 was approximately 1300 times the background rate; by the end of the experiment about 1½ years later, the counting rate had decreased to about 30 times background.

Because the counting rate was fairly high, a correction had to be made for the counts lost during the dead time of the counter. A measurement of the resolution was made by the standard method of splitting a planchet into two pieces and placing a drop containing the S<sup>35</sup> compound on each. The counting rate was then measured for each drop separately and for the two together. The dead time is given by

$$\tau = \frac{2(n_1 + n_2 - n_3)}{(n_1 + n_2) n_3} \tag{2}$$

where  $n_1$  and  $n_2$  are the counts due to the separate drops and  $n_3$  is the count when both drops are measured together. The dead time found for the flow counter used in this experiment was 149.1 µsec, which agrees well with the manufacturer's specifications.

Because the variation in the C<sup>14</sup> counts was small, no correction was made for detector efficiency. The background count measured each day was subtracted from the S<sup>35</sup> count, and the difference was taken as the measured count for that day. In order to obtain the actual count, a correction was made for the counts lost because of the finite dead time of the counter. The measured count can be written as

$$n = N - nN\tau$$

where N is the actual count and  $\tau$  is the dead time of the counter (Eq. 2). Since n and  $\tau$  were known, a value for the actual count, N, was found for each measurement.

$$N = n/(1 - n\tau) \tag{3}$$

During the early part of the experiment when the counting rate was high, the correction for dead time was about 9 percent. This fell off to only a fraction of a percent correction at the end.

at

he

ot

nt,

he

he

b-

a

he

ar-

ne

ch

er.

00

ck-

ge,

714

ent.

vas

ck-

eri-

ing

nes

irly

for

of

eso-

hod

eces

S35

rate

pa-

The

(2)

e to

ount

her.

flow

was

the

C14

was

ack-

was

the

ured

otain nade

inite

ured

s the

Since

the

each

(3)

ment

, the

L. 129

The natural logarithm of N varies linearly with the number of days. In order to find the best-fitting straight line, a regression coefficient of ln N upon the time t was calculated. The regression formula can be written (1)

$$\operatorname{Ln} N = \overline{\ln N} + b(t - \overline{t}) \tag{4}$$

where Ln N is the predicted value of ln N; t is the time in days from the starting point;  $\bar{t}$  is the mean of  $t_1, t_2, \ldots$  $t_{401}$ ;  $\ln N$  is the mean of  $\ln N_1$ ,  $\ln N_2$ , . . In  $N_{401}$ ; and b is the regression coefficient, which for this case is

$$b = \frac{\sum t \ln N - 401 \,\overline{t} \, \overline{\ln N}}{\sum t^2 - 401 \,\overline{t}^2} \tag{5}$$

By applying this equation to the data, a value was found for b. By comparing Eq. 4 with Eq. 1, it is seen that the regression coefficient b is the negative of the decay constant, A. Thus the half-life can be found by substituting -b in the well known equation

$$t_{1/3} = (\ln 2)/\lambda$$
 (6)

The regression is the line which on an average gives the minimum standard error. To determine the degree of linearity of the relationship between time and ln N, it is necessary to calculate the correlation coefficient. This is defined as the square root of the ratio of the sum of squares due to regression over the total sum of squares. If this coefficient is 1 or -1, the total variation is then due to the regression and the relationship between the variables is perfectly linear. Any contamination of the S35 source by other radioactive material would be indicated by a deviation of the correlation coefficient from an absolute value of 1.

In order to estimate the limits of error of the half-life, the standard error of the slope of the regression line was calculated. By adding this standard error to, or subtracting it from, the slope, its effect on the half-life was determined.

The presently accepted half-life of S85 is 87.1 ± 1.2 days. This value was found by Hendricks et al. (2) by least-square fit of 189 points. The correlation coefficient of the best-fit curve for this work was 0.969 and the standard deviation of the count data from the curve was 6 percent. A very weak source was used, resulting in a maximum count which was only 3.1 count/sec above background and a minimum of only 0.7 count/sec above background. Earlier work by Levi (3) indicated a value for this half-life of 88 ± 5 days. This value, however, is based on less than 40 points taken over a period of 500 days.

The value for the half-life of S35 determined in the present experiment is 86.35 ± 0.17 days. The correlation coefficient was found to be -. 9993. This value, being very close to -1, indicates a high degree of linearity and disposes of any possibility that the source contained radioactive material other than S<sup>35</sup>. The half-life measured here was nearly 0.8 day less than that found by earlier investigators but was still within their calculated error. The uncertainty in this measurement is considerably smaller than that of Hendricks et al. both because of the higher counting rate used and because of the fact that more than twice as many points were taken.

> RAYMOND D. COOPER EUGENE S. COTTON

Quartermaster Research and Engineering Command, U.S. Army, Natick, Massachusetts

#### References and Notes

- 1. D. H. Menzel, Fundamental Formulas of Phys-D. H. Menzel, Fundamental Formulas of Physics (Prentice-Hall, Englewood, N.J., 1935), chap. 2; O. L. Davies, Statistical Methods in Research and Production (Oliver and Boyd, London, 1949), chap. 6.
   R. H. Hendricks, L. C. Bryner, M. D. Thomas, J. O. Ivie, J. Phys. Chem. 47, 469 (1943).
   H. Levi, Nature 145, 588 (1940).

- 8 January 1959

#### Geographical Pattern of Crotamine Distribution in the Same Rattlesnake Subspecies

Qualitative individual differences in the composition of the venom of the same ophidian species are of fundamental importance in snake-bite pathology and therapeutics, since, as a rule, ophiotoxicosis results from the venom of a single snake. Knowledge of venom variations and their geographical distribution leads to securing venoms with a more specific composition, and this will facilitate investigations of snake venom. The geographical distribution of these differences in composition would also throw some more light on the phylogeny and genetics of poisonous snakes. Investigations now in course in our laboratory show that qualitative differences in venom composition, within species or subspecies, are common, at least among Brazilian vipers.

In the present paper a particular example of venom differences in the South American rattlesnake [Crotalus terrificus terrificus) or, according to Klauber's revision, C. durissus terrificus (1)], is presented, and the geographical distribution of two biochemical variants in this subspecies, one with and the other without crotamine in its venom, is shown.

Moura Gonçalves (2) isolated, by electrophoresis, from the venom of the South American rattlesnake, a very toxic protein to which he gave the name of crotamine. He also observed that crotamine is present in the venom of some specimens of this subspecies, while its presence cannot be detected in the venom of other specimens (3, 4). This fact induced Moura Goncalves to recognize in this form a biological subspecies which he denominated Crotalus terrificus crotaminicus (3). However, whether crotamine could alternately be present or absent in the venom of the same individual rattlesnake remained to be verified. Its absence would substantiate the existence of biological subspecies variants, while its constant presence in the venom of individual rattlesnakes would permit the study of geographical distribution of the two types (crotamine-positives and crotamine-negatives), adding further ground for recognizing such crotalic subspecies variants.

The paralysis in extension provoked by crotamine in hind legs of mice, as represented by the contraction of the leg extensor muscles, was used in this work to test the presence of crotamine in individual extractions from 530 rattlesnakes. An apparently high dose of venom (0.5 mg per mouse) was tentatively chosen for each test in order to detect crotamine in venoms where this toxin could be found in small concentrations. Two mice were employed for each assay, the venom being injected subcutaneously. It was found, later on, that in a few cases this dose was not sufficient to test venoms with a low crotamine concentration. However, because of the scarcity of venom in some extractions, the dose of 0.5 mg was used. With the venom of some rattlesnakes from northeastern Brazil (state of Ceará) having low cro-

Table 1. Distribution and presence of crotamine in rattlesnakes.

tamine concentration, only doses of 1 mg

provoked positive responses. The venom

of some rattlesnakes from southern Bra-

Assays		Assays	Obser-	Cretamine		
per Snakes for snake (No.) group (No.) (No.)	vation period (mo)	Posi- tives (No.)	Nega- tives (No.)			
1	431	431		252	179	
2	5	10	1	3	2	
3	15	45	2	10	5	
4	30	120	3	16	14	
5	10	50	3	5	5	
6	4	24	4	1	3	
7	4	28	5	1	3	
8	3	24	6	3	0	
9	7	63	7	3	4	
10	5	50	8	4	1	
11	4	44	9	3	-1	
12	1	12	9	0	1	
13	1	13	10	1	0	
14	1	14	10	1	0	
18	9	162	14	7	2	
_	530	1090	_	310	220	

zil, considered as crotamine-negatives, might eventually show crotamine in their venom if the venom were assayed with larger doses, although many determinations made thus far on snakes from this region, with 1 mg of venom, have shown no differences from the results obtained with 0.5 mg.

Electrophoretic determinations, however, are more suitable than the pharmacological assays to detect crotamine in venoms where this toxin is found in low concentrations. On the basis of the sensitiveness of both methods, it is possible to state the existence of crotalic venoms exempt of crotamine. The reliability of the pharmacological assay used in this work is satisfactory, and the results reported by Moura Gonçalves (3), obtained with electrophoresis, are comparable to ours for the same localities. The peculiar geographical distribution corresponding to either type of our rattlesnake also contributes to corroborate both the pharmacological assay and the 0.5-mg dose. Small modifications that could be made on account of dose insufficiency would alter the results very little.

From the 530 rattlesnakes a group of 99 was separated. Several (2 to 14, Table 1) extractions from each snake were tested during the time it survived in captivity.

In this group, the individual secretion showed a constant composition, with regard to crotamine, in all extractions examined; the venom assay of these 99 rattlesnakes revealed 58 that were crotamine-positives, the remaining 41 being crotamine-negatives. The fact that some rattlesnakes always secrete crotamine and others never do show that this secretion may be related to a genetic character.

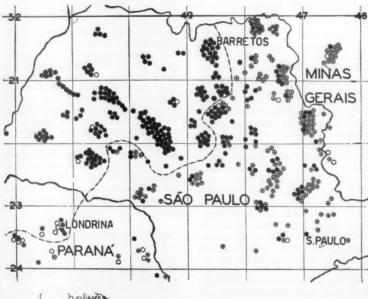
The geographical distribution of both crotamine-secreting and -nonsecreting rattlesnakes is shown in Fig. 1, where it can be seen that east of the 49th meridian and south of the 22nd parallel the crotamine-negative rattlesnakes (crossed circles) predominate, although, in this region, the two types cohabit in a mixed distribution so that, in the same locality, specimens with the two venom variants may be found. This fact may indicate

that in this region the rattlesnakes are in a hybrid condition. To the west of the states of São Paulo and Paraná, an increase in the number of the crotaminepositive rattlesnakes (black circles) is observed until a region is reached where only crotamine-positive rattlesnakes are found (crotamine region). In the map, a dot-and-dash line separates the two regions. The rattlesnakes in the crotamine region, apparently are still in a genetically pure condition. The two rattlesnake variants seem to be distributed in geographical mosaics, since in very distant places, beyond those shown on the map, is found either one or the other type of rattlesnake, or both together; thus, we detected crotamine in the rattlesnake venom from the state of Ceará (northeastern Brazil); other workers (2-5) have verified that in pools of rattlesnake venom from the state of Goiás (middlewestern Brazil), in northern Brazil, and some places of northeastern Brazil, only the noncrotamine-secreting rattlesnakes can be found. The rattlesnakes of Argentina (5) all appear to be crotamine-positive.

of

In regard to color, the dried crotalic venom can be either white or yellow, the yellow color being related to its content of ophio-L-amino acid oxidase. South of the 23rd parallel rattlesnakes having yellow venom predominate (open circles). The crotamine region (white venom), extends from western São Paulo into northern and northwestern Paraná. In the latter state a small area is discriminated, in the lower part of the crotamine region, where the rattlesnake venoms contain crotamine and are yellow in color; here, a new component (yellow component) is superimposed on the crotaminic venom which is responsible for the change in the venom color.

These investigations show the following. (i) The venom gland of rattlesnakes seems to be genetically provided to secrete or not to secrete crotamine. (ii) Two geographical regions can be delimited with regard to crotamine secretion, one where only crotamine-secreting rattlesnakes are found (genetically pure), the other (larger) where crotamine and noncrotamine-secreting rattlesnakes are found in mixed distribution (hybrid region). This geographical distribution also appears to confirm the Mendelian character of crotamine secretion. (iii) More data are added to the discrimination of the two rattlesnake variants which induced Moura Goncalves to recognize Crotalus terrificus crotaminicus as a "biological" subspecies. (iv) Investigations in many directions might be helped if morphological data could be checked by venom composition criteria in poisonous snake taxonomy. (v) The generally accepted concept of venom composition homogeneity in snake species must be re-



BRAZIL PERÚ BOLIVÍA ARGENTINA

Fig. 1. (Top) Geographical distribution of rattlesnakes secreting (black circles) and not secreting (crossed circles) crotamine. The open circles represent rattle-snakes with yellow venom. The dot-anddash line separates the region where crotamine-positive rattlesnakes are found from the region where hybrids are found. (Left) Locale of the regions in South America.

garded with caution, since investigations of venom composition are usually made with pools of extractions from a large number of snakes, and the individual venom composition is thus hidden in the species' venom pool (6).

S. SCHENBERG

Laboratório de Fisiologia, Instituto Butantan, São Paulo, Brazil

#### References and Notes

L. M. Klauber, Ratilesnakes (Univ. of California Press, Berkeley, 1956), vol. 1.
 J. M. Gonçalves and L. G. Vieira, Anais acad. brasil. cienc. 22, 141 (1950).
 —, ibid. 28, 365 (1956).
 —, in Venoms, E. E. Buckley and N. Porges, Eds. (AAASci., Washington, D.C., 1956), p. 261.

1956), p. 261.
A. Barrio and O. Vital Brazil, Acta Physiol. Latinoam. 1, 291 (1951).
I am indebted to D. Cavalheiro for his technical aid in this work. This work was supported in part by a personal grant from the Brazilian National Research Council.

30 December 1958

#### **High-Energy Phosphates during** Long-Term Hibernation

Abstract. Adenosine triphosphate (ATP) and phosphocreatine (PC) show contrasting levels in muscle and liver after short and long periods of hibernation. In prolonged hibernation cardiac and skeletal muscle PC continues to maintain ATP, but at lower levels. In the liver, control levels for these compounds are regained.

During the course of experiments with hibernating ground squirrels, Citellus tridecemlineatus, we were fortunate in having nine animals hibernate for a month without interruption. Since past reports (1) have pertained to an uninterrupted hibernation period of 3 to 5 days (shortterm hibernation), we decided to compare those results with results obtained from the animals that hibernated a month (long-term hibernation).

The control animals were kept in an environmental temperature of 25° to 27°C and were anesthetized with Nembutal before sacrifice. The hibernating animals were kept in a cold room at 3° to 5°C, and tissue was removed for analysis within 30 seconds after the animal was first handled. At the time of sacrifice the thoracic cage was opened, and the heart was frozen in situ with mixture of ether and Dry Ice and removed. The same procedure was applied to the liver and the muscle from the hind limbs. For phosphate analysis 0.85- to 1.00-g samples of tissue were extracted with cold 10-percent trichloroacetic acid at 0°C, and the determinations were based on the method of Fiske and Subarrow (2). Inorganic phosphate (IP) was precipitated with calcium at an alkaline pH (a); inorganic phosphate, including phosphocreatine, was hydrolyzed with molybdic acid at room temperature for 30 minutes (b); and total acid-soluble phosphate was hydrolyzed by heating at 100°C in 1N HCl for 8 minutes (c). Accordingly, the following values are obtained: IP = a; PC = b - a; and APP =c-b. Adenosine polyphosphate (APP), which is actually a combination of adenosine triphosphate and adenosine diphosphate, is reported in this paper as adenosine triphosphate (ATP). Glycogen was determined by the procedure of Kemp and Van Heijningen (3).

The results show that when cardiac muscle of the long-term hibernators is compared either with that of the controls or that of the short-term hibernators, ATP (P < .05) and PC (P < .01) decrease significantly and to approximately the same degree (Fig. 1). Apparently the longer the heart beats at the extremely slow hibernating rate of 15 to 25 beats per minute, the smaller the high-energy phosphate content. Since the ATP/PC ratio is greatest (5/1) at this time, most of the high-energy phosphate present is ATP, the "active" form which is supplying energy, at the expense of PC, to the slow but continually beating heart.

Although skeletal muscle shows a significant (P<.01) decrease of 49 percent in both ATP and PC when longterm and short-term hibernation are compared, the ATP/PC ratio is the same, 1/1. The quantities are smaller, but when one takes into consideration the lack of movement over a longer period of time, this is plausible,

In the liver ATP is decreased 55 percent (P < .01) and PC is increased 107 percent (P < .02) when the long-term hibernators are compared with the shortterm ones. However, when the shortterm hibernators are compared with the controls the reverse is true; ATP is increased 120 percent (P < .01) and PC is decreased 62 percent (P < .01). It appears that the high-energy phosphate compounds of the long-term hibernators have reached an equilibrium comparable to that of the controls.

Glycogen values of the long-term hibernators, when compared with those of the short-term hibernators, showed the following decreases: cardiac muscle, 36 percent; skeletal muscle, 3 percent; liver, 9 percent. None of these changes are significant.

An increase in the hibernating period from 5 to 30 days decreases both ATP and PC in cardiac muscle. Phosphocreatine shows the greater decrease because it is maintaining ATP which is considered the "active" form (4). Although the high-energy phosphate content decreases in skeletal muscle, the ATP/PC ratio remains approximately the same. The slowly beating heart is using ATP and depleting PC while the stationary limb muscle maintains metabolic function at the 1/1 ratio of short-term hibernation with lower levels of the compounds. The increase in liver in organic phosphate during long-term hibernation is difficult to explain but may be due to an increased breakdown of organic phosphate compounds resulting from the interruption of the activity of certain enzyme systems. With metabolic transformations apparently at a minimum, ATP and PC have resumed control

In the regulation of metabolism, gly-

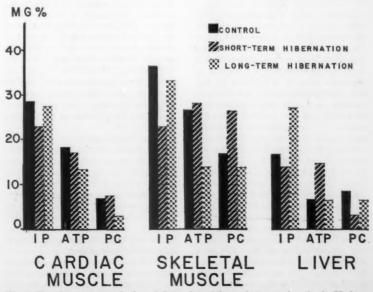


Fig. 1. Phosphate content of selected tissues from hibernating ground squirrels. IP, inorganic phosphate; ATP, adenosine triphosphate; PC, phosphocreatine.

colysis is inversely dependent upon the concentration of ATP (5). Since none of the tissues have undergone sudden changes necessitating quick energy, thus lowering ATP and stimulating glycolysis, glycogen levels do not show any significant differences (6).

> MARILYN L. ZIMNY ROY GREGORY

Department of Anatomy, Louisiana State University School of Medicine, New Orleans

#### References and Notes

- M. L. Zimny and R. Gregory, Am. J. Physiol. 195, 233 (1958).
- 195, 233 (1958).
   W. W. Umbreit et al., Manometric Techniques (Burgess, Minneapolis, Minn., 1957).
   A. Kemp and A. J. M. K. Van Heijningen, Biochem. J. 56, 646 (1954).
   S. Soskin and R. Levine, Carbohydrate Metabolism (Univ. of Chicago Press, Chicago, Ill., 1959)
- 1952) 1992. N. O. Kaplan, The Enzymes, J. B. Sumner and K. Myrback, Eds. (Academic Press, New York, 1951), vol. 2.
- This work was supported by research grant No. A-1490 from the National Institute of Arthritis and Metabolic Diseases.
- 26 January 1959

#### Factors Influencing the Effect of B-Propiolactone on Chromosomes of Vicia faba

Abstract. The effect of \$\beta\$-propiolactone on chromosomes is independent of pH, oxygen tension, and some metabolic inhibitors. It is influenced by temperature, concentration, and pretreatments with dinitrophenol. Interphase sensitivity and localization of breaks are discussed in terms of the action of β-propiolactone and the relationship of β-propiolactone to other radiomimetic compounds.

Several studies (for example, Kihlman's, 1) have indicated that with few exceptions each of a now long list of radiomimetic compounds differs from the others in its mode of action (that is, in interphase sensitivity and preferential breakage) or in its dependence on oxygen tension, temperature, and metabolic activity. In general, most radiomimetic chemicals can be grouped into two classes: (i) weakly reactive compounds such as maleic hydrazide and 8-ethoxycaffeine whose observed effects are much enhanced and depressed by factors that alter the metabolic state of the cell at the time of exposure; (ii) strongly reactive compounds whose observed effects seem to be somewhat independent of experimentally altered exposure conditions, acting as if by the law of mass action. It seems, then, that the less reactive chemicals are dependent on, and the more reactive chemicals independent of, oxidative metabolism systems for their observed effect. The work reported in this paper (2) indicates that β-propiolactone (BPL) is a substance belonging to the

more reactive group, although differences in action are discernible.

β-Propiolactone is the simplest of a number of related compounds. It is used industrially as a plasticizer. Our interest in an understanding of its action, apart from determining its place in our study of the comparative effects of mutagens, stems partly from its promise as a chemotherapeutic agent in oncology. Its mutagenic properties have been demonstrated in yeast, bacteria, and Neurospora, while Smith and Lotfy (3) have demonstrated its effectiveness as a radiomimetic agent, testing it on the chromosomes of Vicia and Allium.

Our work is unlike that of Smith and Lotfy in two basic respects: metaphase rather than anaphase chromosomes were scored and environmental conditions were altered to test their influence on the effect of β-propiolactone in an attempt to elucidate the mechanism by which it acts in producing chromosomal aberrations. The lateral root-tip chromosomes of Vicia were used. Smith and Lotfy employed primary roots in their study, but the erratic and often high frequency of spontaneous aberrations in the primary roots makes the use of laterals, roots, in which spontaneous aberrations are generally absent or are present in a frequency of less than 1 percent, advantageous in this type of work. There is also the added advantage that chromosomes from roots of the same bean, presumably with the same genetic constitution, can be treated and tested.

The techniques of culture, treatment and recovery, and slide preparation have been previously described (4). Fresh preparations of BPL were always used in treatments because BPL has a tendency to break down in solution. A variety of BPL concentrations were tested, but  $7 \times 10^{-3}M$  seemed to be the most effective since it resulted in a high frequency of aberrations and a low frequency of cell death. Only experiments in which this concentration was used are reported. The roots were treated at 17°C for 30 minutes and were allowed to recover for 48 hours at 25°C before

β-Propiolactone seems to act on chromosomes most effectively when the chromosomes are in early interphase. Few aberrations are observed after 24 hours' recovery, a peak frequency is reached after 48 hours, a somewhat lower frequency occurs after 72 hours, and an appreciable decline sets in by 96 hours. The prolonged delay of the peak frequency is due largely to the depressing effect of BPL on the mitotic rate.

The first burst of mitosis following the suppression of cell division coincides with the peak frequency, but whether BPL causes cells in prophase to regress to earlier stages is not known, although

Table 1. Effect of temperature on the activity of BPL.

Tem- perature (°C)	No. of cells	Isochro- matids (%)	Ex- changes (%)
5	100	22	3
17	100	43	10
25	100	43	29
37	Lethal		

no polyploid cells result from the suppression. It can be assumed, therefore, that the principal delay occurs at a stage prior to DNA synthesis and chromosome replication. When a low frequency of aberrations was encountered, it was paralleled by a low mitotic rate and a high frequency of dead cells. Lower concentrations of BPL interfered less with the mitotic rate but did not appreciably affect the time of appearance of aberrations. Our findings in this regard are in accord with those of Smith and Lotfy. We do not agree, however, on the time that definitive chromosome aberrations occur. One can see abnormal cells so far as the presence of sticky bridges and lagging chromosomes is concerned. This is especially true with regard to the satellites of the long chromosomes which often lag at anaphase to the extent that they appear to be fragments. Some of the latter abnormalities are seen at 24 hours, but they are very few in number, mitosis being severely inhibited at this time. The results reported here are similar to those reported by Smith and Srb (5) so far as time of appearance of aberrations is concerned.

The aberrations induced were entirely of the chromatid rather than the chromosome type. As is usual, isochromatid aberrations were predominant; interchanges were about one-third as frequent as isochromatids, and single chromatid deletions-never a large class of experimentally induced aberrations in Viciawere conspicuously absent. The presence of fragment types, as contrasted to the anaphase bridges reported by Smith and Lotfy, cannot be confirmed by these experiments. We disagree therefore with Smith and Lotfy's conclusion that sister and nonsister fusion of broken ends is

Table 2. Effect of dinitrophenol (DNP) (1×10-4M at 17°C for 2 hours) on BPL activity.

Treat- ment	No. of cells	Iso- chro- matids (%)	Ex- changes (%)
BPL	200	41.5	24.5
DNP + BPL	100	96	22
BPL + DNP	100	98	51

low; in fact, the absence of single deletions and the apparent completeness of isochromatid and exchange aberrations leads to the conclusion that just the opposite situation prevails—that is, the frequency of fusion of broken ends is very high. It might be well, however, to point out that the fusion or exchange scored in metaphase does not always result in an anaphase bridge. Wolff (6) has discussed this phenomenon in some detail, while Conger (7) has presented evidence that some of the discrepancy between these scoring systems is due to "free fall" and broken bridges.

e.

ge

1e

of

as

a

n-

th

ly

a-

in

fy.

ne

ns

ar

nd

nis

el-

ch

at

he

rs.

sis

he

ose

as

n-

ely

ro-

tid

er-

ent

tid

ri-

ace

the

nd

ex-

ith

ter

is

IP)

PL

es

129

Like other chemicals capable of inducing aberrations, BPL is preferential in its action. The short chromosomes were much more frequently broken than the long pair. The S/L ratio (determined by dividing the number of long chromosomes affected into the number of short chromosomes affected) is a measure of this preference. X-rays, which break short and long chromosomes at random, induce an S/L ratio of 2.5. Treatments with BPL result in an S/L ratio higher than 6.0 (only 464 chromosome breaks were analyzed). Actually, the action of BPL is even more restricted than the S/L ratio indicates. β-Propiolactone selectively results in breakage in those segments known to be heterochromatic and to be located in the long arm of the short chromosomes. The few breaks produced in the long chromosomes were located in the heterochromatic regions on either side of the centromere. β-Propiolactone is similar, then, to mustard and diepoxide so far as site of breakage is concerned and is dissimilar to 8-ethoxycaffeine and maleic hydrazide, which attack the nucleolar organizer region and the centric heterochromatin of the long chromosome, respectively. The breakage frequency induced by BPL treatments is not modified by changes in pH or oxygen tension or by such metabolic inhibitors as NaN3 or NaF. It is modified, however, by temperature change. The higher the temperature the higher the breakage frequency within the range tested. These data are presented in Table 1. The influence of temperature on the BPL effect is similar to its influence on the action of mustard, diepoxide, and maleic hydrazide but dissimilar to its influence on KCN, the final effect of which is independent of temperature and pH changes but dependent on oxygen ten-

It has previously been demonstrated (1) that dinitrophenol has a marked inhibitory influence on the effect of maleic hydrazide and 8-ethoxycaffeine as a pretreatment but not as a posttreatment and on diepoxide as a posttreatment but not as a pretreatment. It has no observable effect on KCN action. The influence of dinitrophenol on BPL is strikingly different in that both pre- and posttreatments with it result in an increased frequency of aberration (Table 2). Since dinitrophenol is believed to uncouple oxidation from phosphorylation, it is tempting to suggest that BPL, despite its reactive nature, is more reactive in the absence of an intact energy source. Whether this source is similar to that described for intact nuclei (8) or is of a cytoplasmic nature remains to be determined. It is conceivable that the influence of dinitrophenol on BPL is on rejoining and not on breakage, although the exchange rate is not affected as much as the isochromatid rate.

CARL P. SWANSON TIMOTHY MERZ

Biology Department, Johns Hopkins University, Baltimore, Maryland

#### References and Notes

- B. A. Kihlman, J. Biophys. Biochem. Cytol. 2, 543 (1956).
- This work was supported in part by the Atomic Energy Commission, the National Science Foundation, and the National Institutes of Health.
- 3. H. H. Smith and T. A. Lotfy, Am. J. Botany
- T. Merz, J. Biophys. Biochem. Cytol. 5, 135
- 5. H. H. Smith and A. M. Srb, Science 114, 490
- S. Wolff and H. E. Luippold, Nature 179, 208
- 7. A. Conger, Abstr. 10th Intern. Congr. Genetics
- A. Conger, North Politics, Congr. Genetics 2, 57 (1958). V. G. Allfrey, A. E. Mirsky, S. Osawa, Nature 176, 1042 (1955).
- 20 November 1958

#### An Explanation of the Liesegang Phenomenon

Abstract. Periodic band precipitation in porous media is explained by means of the Hirsch effect (specific semipermeability of the precipitate occurring only as long as both the precipitate-forming ions are present). The possibility of getting Liesegang bands in immunological precipitates is underlined, and a suggestion is made how to

Many authors have attempted to explain the periodic precipitation phenomenon in porous media or gels, found by Liesegang (1), in different ways, which, although often more or less plausible, are never wholly satisfactory, since they are either incomplete or do not convincingly demonstrate that the proposed mechanisms must give rise to band formation. Hedges (2) and Veil (3) give complete reviews of different theories, mentioning Ostwald's supersaturation theory (4) [refuted by Hatschek's experiments (5)], Dhar and Chatterji's coagulation theory (6), Bradford's adsorption theory (7), Fricke's diffusion theory (8) (see also 9), and Mc-Laughlin and Fischer's membrane theory (10). A more recent review is given by Stern (11). Different aspects of the diffusion theory are further given by Yanagihara (12) (influence of d-c and a-c electric fields), Wagner (13) (a mathematical analysis), and Matalon and Packter (14) (protecting influence of the gel).

The Hirsch effect (15), described 60 years after Liesegang's first paper on this phenomenon, now permits a satisfactory and general explanation. Hirsch (15) observed that, in certain cases, two solutions of electrolytes which can precipitate with one another, when diffusing toward one another through a membrane (thin slice of a gel), endow the membrane with quite remarkable permeability properties. The membrane becomes in such cases perfectly impermeable to the ions that formed the precipitate but remains permeable to other ions and to the solvent (see also Mc-Laughlin and Fischer, 10).

The remarkable impermeability to the ions that form the precipitate layer is illustrated by the following experiment [see 15 (a), Table I]: A cellophane membrane separating solutions of (i) 0.1N Ba(OH)<sub>2</sub> and (ii) 0.1N H<sub>2</sub>SO<sub>4</sub> gave rise to a membrane potential of 670 my. This value corresponds well with the value E calculated from

$$E = 2.3026 \frac{RT}{F} (pH_1 - pH_{11})$$

This is in perfect accord with the assumption that the membrane is completely impermeable to the ions Ba++ and So, -- but permeable to H+ and OH-. The same membrane, after the formation of the BaSO4 barrier inside it, but with Na+ substituted for Ba++, or with Cl- substituted for SO4--, showed a membrane potential of approximately 65 mv, equal to the membrane potential found with untreated cellophane under the same conditions; the semipermeability now had vanished.

At first sight this observation appears to exclude any formation of multiple precipitate bands, because the formation of the first band, which is impermeable to the forming ions, would stop the ions from crossing it to form a second band farther on. But Hirsch (15) also observed that the precipitate layer inside the membrane remains impermeable to the forming ions only as long as small quantities of the forming ions are present in solution on either side of the membrane. As soon as one of these ions is lacking on one side of the membrane, the precipitate layer in the membrane can be crossed, after a longer or shorter lapse of time, by the other ion.

Without attempting for the moment to discuss the explanation of this Hirscheffect, expressed by the condition "specific semipermeability of the precipitate occurs only as long as both the precipitate-forming ions are present," the effect by itself suffices to explain the Liesegang phenomenon. As a matter of fact, Liesegang (16), Hedges (2), Bradford (7), and Holmes (17) observed that between two precipitate bands the solution in the gel is completely or almost completely depleted of one of the forming ions (generally the ion initially present in the lowest concentration is the one that is lacking). Stanfield (18) observed that a strong concentration difference between the two reagents predisposes to the formation of macroscopic multiple bands [see also Bradford (7) and Holmes (17)]. Wilson and Pringle (19) and Salvinien and Kaminsky (20) noticed the same tendency with immunological precipitates.

Our explanation of the Liesegang phenomenon is most nearly approached by McLaughlin and Fischer's hypothesis (10), which states that while the precipitate bands may be somewhat permeable to many substances, they certainly are impermeable to the forming substances. According to these authors, the barriers then lose their impermeability after some time, by a mechanism for which they do not offer a satisfactory explanation. The only thing lacking in their theory, to make it conclusive, is the condition from the Hirsch effect: that these precipitates constitute a membrane that is impermeable to the forming substances only as long as the forming substances are both present on either side of the membrane. Thus, once a band is formed by precipitation of two reagents that meet in a gel (or another porous medium such as filter paper) see Van Oss, Fontaine, Dhennin, and Fontaine (9) and Milone, Cetini, and Ricca (21)], that band remains impermeable until one of the reagents is exhausted by precipitation or by absorption on the precipitate, at least in the immediate vicinity of the membrane [see Bradford's adsorption experiments (7)]. Only from that moment can the other reagent cross the barrier, until it again encounters farther on a sufficient amount of the first reagent, with which it will form a second band, and so on.

Our theory may also throw some light on the formation of immunological precipitate bands in porous media, where it is of great importance to be able to avoid confusion of Liesegang bands with bands due to a multiple immunological system [Wilson and Pringle (19); Salvinien and Kaminsky (20); Van Oss, Fontaine, Dhennin, and Fontaine (9)]. The mobility of the bands [Oudin (22)] does not necessarily exclude the occurrence of a Liesegang phenomenon, particularly not in the cases where the precipitate is soluble in an excess of one of the reagents, like colloidal and immunological precipitates (Bechhold, 23), and even sometimes precipitates of electrolytes [Pringsheim (24), and Cetini and Ricca (25)]. The best way to avoid the formation of multiple macroscopical Liesegang bands is to operate with equivalent concentrations of reagents.

Many other phenomena of periodic structure may be explained in a similar way: the very creation of the first structural elements opposes a temporary barrier to the transport of a forming substance. The barrier then loses its function as such for reasons inherent to its growth. thus leaving the way free to the construction of the next structural element. The periodicity is determined by the magnitude of negative feedback arising out of the interaction between the formation and the degeneration of the barrier.

C. J. VAN Oss\* Van't Hoff Laboratory, University of Utrecht, Utrecht, Netherlands

P. HIRSCH-AYALON

Central Institute for Nutrition Research, Utrecht

#### References and Notes

- 1. R. E. Liesegang, Naturw. Wochschr. 11, 353
- (1896). E. S. Hedges, Liesegang Rings and Other Periodic Structures (Chapman and Hall, London. 1932).
- S. Veil, Les périodicités de structure (Hermann, Paris, 1934).
  W. Ostwald, Z. physik. Chem. (Leipzig) 23,
- 365 (1897).
- 365 (1897).
   E. Hatschek, Kolloid-Z. 10, 124 (1912).
   R. N. Dhar and A. C. Chatterji, ibid. 31, 15 (1922); 37, 2, 89 (1925).
   S. C. Bradford, in Colloid Chemistry, J. Alex-
- ander, Ed. (Chemical Catalog Co., New York, 1926), vol. 1, p. 790. R. Fricke, Z. Physik. Chem. (Leipzig) 107, 41 (1923).
- 41 (1923). C. J. van Oss, M. Fontaine, L. Dhennin, M. Fontaine, Compt. rend. 245, 407 (1957). By rheophoresis, Liesegang phenomena can be created with hydrodynamic flow as the transport method, which proves that diffusion is ot necessary.
- not necessary.

  G. D. McLaughlin and M. H. Fischer, Kolloid-Z. 30, 13 (1922).

  K. H. Stern, Chem. Revs. 54, 79 (1954).

  A. Yanagihara, Nippon Kagaku Zasshi 76, 161,
- 165 (1955). C. Wagner, J. Colloid Sci. 5, 85 (1950). Matalon and A. Packter, ibid. 10, 46
- (1955) P. Hirsch-Ayalon, (a) Rec. trav. chim. 75, 1065 (1956); (b) J. Polymer Sci. 23, 697 (1957)
- R. E. Liesegang, Z. angew. Chem. 23, 2124 (1910)
- (1910).
  H. N Holmes, in Colloid Chemistry, J. Alexander, Ed. (Chemical Catalog Co., New York, 1926), vol. 1, p. 796.
  J. Stanfield, Am. J. Sci. 43, 1 (1917). Stanfield observed that with equimolar concentrations with the control of the control o
- tions only one band can be obtained, which, however, consists of a great many microscopi-cally thin bands.
- nowever, consists of a great many microscopi-cially thin bands.

  M. W. Wilson and B. H. Pringle, J. Immunol.
  73, 232 (1954).

  J. Salvinien and M. Kaminsky, Compt. rend.
  240, 257 (1955).

  M. Milone, G. Cetini, F. Ricca, J. chim. phys.
- J. Oudin, Ann. inst. Pasteur 75, 30 (1948). H. Bechhold, Z. physik. Chem. (Leipzig) 52, 185 (1905).
- N. Pringsheim, ibid. 17, 473 (1895). G. Cetini and F. Ricca, J. chim. phys. 55, 323
- Present address: Laboratory of Physical Biochemistry, National Veterinary College, Alfort (Seine), France.
- 5 December 1958

#### Prolongation of Response of Node of Ranvier by Metal Ions

Abstract. The response of the node of Ranvier can be prolonged up to 5 to 6 seconds by addition to the medium of minute amounts of certain metal ions. This prolongation involves a change from a triangular to a rectangular configuration. The properties of the prolonged nerve-fiber responses are very similar to those of heart muscle.

Electrical responses of the node of Ranvier whose falling phase is markedly prolonged can be obtained by exposure of the node to such alkaloids as brucine, emetine, sinomenine, and heroine (1), to certain derivatives of morphine (3), and to strychnine (4), as well as by exposure to hypertonic solutions (2). Prolonged responses were also obtained in the giant axon of the squid with the intracellular injection of tetraethylammonium chloride (5, 6). Following repetitive stimulation, many excitable cells show a type of "memory" in the form of a prolonged response. This phenomenon has been observed in the node of Ranvier of the toad (7, 8), giant axon of sepia (9), aplysia nerve cell (9), the ommatidium of the horseshoe crab (10), the supramedullary ganglion cell of the puffer fish (11) and in Noctiluca, a protozoan (12). Somewhat less marked prolongations of nerve fiber responses have been obtained with low temperatures (13), high pressures (14, 15) and by replacing H<sub>2</sub>O in the fluid medium with D<sub>2</sub>O (16).

The prolonged responses (especially the markedly prolonged responses) show many properties in common with those of the normal response of heart muscle. These similarities involve the configuration, the instability of the duration, the time course of the impedance changes, the refractory period, the resistance to lowered sodium or increased potassium, and the effects upon the duration and configuration of temperature changes, of pressure changes, of polarization, of frequency of stimulation, and of a large number of chemicals (5, 7, 17). In the experiments reported here (18), a prolongation of the response of the node of Ranvier was obtained by the external application of metal ions. Brief reference to these experiments was made in a previous publication (6).

Both the node of Ranvier and the giant axon preparation were used in these experiments. Single myelinated nerve fibers were isolated from the nerve innervating the semitendinosus or sartorius muscle of the toad (Bufo marinus). This technique has been described previously (1). Action currents of the node of Ranvier were recorded by the "bridge-insulator" technique (1). Action potentials of the node of Ranvier were recorded by the method of Tasaki and Frank (19). Intracellular action potentials from the squid (Loligo pealii) were recorded by a modification (5, 15) of Hodgkin and Huxley's (20) and Curtis and Cole's (21) methods. Intracellular injections into the giant axon were carried out with a modification (7) of the methods of Arvanitaki and Chalazonitis (22), Hodgkin and Keynes (23) and Grundfest et al. (24). The control frog Ringer's solution contained 0.22 percent NaHCO3, 0.014 percent KCl, 0.65 percent NaCl, and 0.012 percent CaCl<sub>2</sub> · 2H<sub>2</sub>O. In some experiments 0.001 percent NaHaPO4, 0.2 percent glucose, or both, was added. Experiments were carried out at room temperature (21° to 25°C).

. . . . . . . .

n

a

e e

,

e

8

,

y

e

9

ŀ

e

S. 0

d

of

9,

e

e

of

al

e

e.

ne

se

re

1-

18

is ly n. 11ls

29

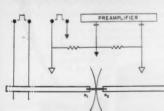


Fig. 1. Prolongation of response of node of Ranvier by metal ions. (Top) Before application of NiCl<sub>2</sub>. (Middle) After application of 5×10<sup>-4</sup>M NiCl<sub>2</sub>. Temperature, 23°C. Bar at right subtends 1 × 10-8 amp. Time marker, 1 msec. (Bottom) "Bridge-insulator" method used in recording action currents.

The following metal ions were employed: Ni++, Co++, Be++, and Cu++. The upper two frames of Fig. 1 illustrate the effect of Ni++ upon the duration of the action current. The "bridge-insulator" method for recording the action current is illustrated at the bottom of Fig. 1. The response of the node in normal Ringer's solution is shown in the top frame of Fig. 1. In the middle frame, the response was recorded after replacement of the fluid surrounding the node with Ringer's solution containing 10-4M NiCl<sub>2</sub>. The response is prolonged by development of a plateau in the falling phase. The extent of prolongation obtained with Ni++ was variable. Increases in duration of more than 10,000 times normal have been obtained.

Results obtained with Be++ and Co++ were generally comparable. With Cu++ the effects were not always clearly demonstrable. The minimal concentration of Ni++ required to produce the prolongation was found to be variable. In some experiments, an effect could be demonstrated with  $5 \times 10^{-6} M$  NiCl<sub>2</sub>. In most instances, however, higher (10-4M) concentrations were required. The threshold concentration for the other metal ions was not determined. These ions were effective in concentrations of 10-4M or higher. When much higher concentrations of any of these ions were used, the prolongation was less marked, and the amplitude was lower, or the node became completely inexcitable. When the node was freed of the adhering tissues, the effect of Ni++ was instantaneous. Within a certain range an increase in the concentration of Ni++ resulted in an increase in the prolongation. Often Ni++ resulted in a slight increase in the amplitude of the response.

When the treated node was washed with normal Ringer's solution, the effect of the ions was sometimes reversible. Very often, however, the effect was not reversed. Sometimes, but not always, under these conditions, where the prolonged response cannot be shortened by washing with normal Ringer's solution, washing with Ringer's containing a small amount of Versene resulted in a reversal of the effect.

The effect of Ni++ upon the action potential of the node was similar to that upon the action current, Extracellular application of Ni++ to the giant axon of the squid did not result in a comparable prolongation of the response. The possibility that the lack of effect on this axon was due to an inability of Ni+ to penetrate the axonal surface was considered. In this connection, Ni++ was injected into

the giant axon in such a volume and concentration as to give a final concentration of 10-3 to 10-4M. This procedure did not result in a marked prolongation of the response. The example of an agent that prolongs the response of the node but does not prolong the response of the giant axon is not unique. Repetitive stimulation and hypertonic saline (two conditions known to prolong the response of the node) did not prolong the response of the giant axon of Loligo pealii. On the other hand, such agents as low temperature, high pressure, and D<sub>2</sub>O affect the duration of both types of fibers in a similar manner.

We have no clear idea about the exact mechanism whereby these metal ions exert their effect. In accordance with the two-stable potential states concept of excitation, the metal ion effect can be described as an increased stabilization of the upper potential level.

C. S. SPYROPOULOS R. O. BRADY

National Institute of Neurological Diseases and Blindness, National Institutes of Health, Bethesda, Maryland

#### References and Notes

- I. Tasaki, Nervous Transmission (Thomas, Springfield, Ill., 1953).
   J. Neurophysiol. 13, 177 (1950).
   C. S. Spyropoulos and R. O. Brady, in preparations.

- ration.
  J. Maruhashi, T. Otani, H. Takahashi, M. Yamada, Japan J. Physiol. 6, 175 (1956).
  I. Tasaki and S. Hagiwara, J. Gen. Physiol. 40, 839 (1957).
  R. Brady, C. S. Spyropoulos, I. Tasaki, Am. J. Physiol. 194, 207 (1958).
  C. S. Spyropoulos, J. Gen. Physiol. 40, 19 (1956).
- (1956)
- I. Tasaki, in Microphysiologie comparée des éléments excitables (Centre National de le Recherche Scientifique, Paris, 1957).

  A. Arvanitaki and N. Chalazonitis, personal
- communication; in Microphysiologie comparée des éléments excitables (Centre National de la Recherche Scientifique, Paris, 1957; L. Tauc,
- M. Fuortes, personal communication.
  M. Bennett and H. Grundfest, personal com-
- J. Chang and I. Tasaki, personal communica-
- tion.

  I. Tasaki and M. Fujita, J. Neurophysiol. 11, 311 (1948); A. L. Hodgkin and B. Katz. J. Physiol. (London) 109, 240 (1949).

  C. S. Spyropoulos, Am. J. Physiol. 189, 214 13.
- C. S. S (1957).
- 16.
- (1957).

  —, J. Gen. Physiol. 40, 849 (1957).

   and M. E. Ezzy, in preparation.

  C. S. Spyropoulos, in preparation.

  We acknowledge with thanks the kind assistance of Ichiji Tasaki.

  I. Tasaki and K. Frank, Am. J. Physiol. 182, 572 (1958). 18.
- 572 (1955)
- A. L. Hodgkin and A. F. Huxley, Nature 144, 710 (1939).
- H. J. Curtis and K. S. Cole. J. Cellular Comp.
- H. J. Cartis and K. S. Cole. J. Cestular Comp. Physiol. 19, 135 (1942).
  A. Arvanitaki and N. Chalazonitis, Arch. sei. physiol. 5, 207 (1951).
  A. L. Hodgkin and R. D. Keynes, J. Physiol. (London) 131, 592 (1956).
  H. Grundfest, C. Y. Kao, M. Altamirano, J. Gen. Physiol. 38, 245 (1954).
- 26 December 1958



Rapid, Precise Pipetting with

#### **HAMILTON PIPET CONTROLS**

DUAL CONTROL provides for extremely accurate pipetting and liquid transfer with Hamilton Pipet Controls. Simply raise the liquid meniscus with the free-sliding plunger almost to the calibration line, then use the thumbwheel control to bring the meniscus to the scribe line with complete accuracy. Pipet Control features include:

- · Glass and stainless steel construction
- Tygon tubing connection to pipet provides clean, flexible coupling
- 1 ml, 2 ml and 5 ml maximum capacities available

Order Direct - or write for literature and prices - today!

### HAMILTON COMPANY, INC.

DEPARTMENT K

1134 WHITLEY STREET . WHITTIER, CALIFORNIA

A Complete Line of Precision,

Radiochemical Handling Equipment

## DETERMINE AMINO ACIDS

conveniently economically accurately

ba

microbiological assay methods described fully in our *free* brochure using our chemicallydefined media—low blanks and optimum response to assay organisms—and our durable, lightweight, precision-machined

SPECIAL RACKS



ORGANIC RESEARCH CHEMICALS
AND BIOLOGICAL PRODUCTS

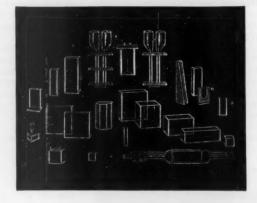
write for catalogue



H. M. CHEMICAL COMPANY, LTD.

1754 TWENTY-SECOND STREET SANTA MONICA, CALIFORNIA

# GLASS ABSORPTION CELLS made KLETT



SCIENTIFIC APPARATUS

Klett-Summerson Photoelectric Colorimeters—
Colorimeters — Nephelometers — Fluorimeters—
Bio-Colorimeters — Comparators — Glass Standards—Klett Reagents.

Klett Manufacturing Co. 179 East 87 Street, New York, New York

# FOR EXPLORING MICROWAVE OPTICS . . . CENCO®

MICRO-WAVE APPARATUS

A valuable new teaching aid for school and laboratory that demonstrates principles of physical optics at a meter stick rather than microscope level. Also illustrates basic radar. Special manual outlines 17 experiments.

Write for details.





No. 80422 Micro-Wave Apparatus, with transmitter tube.....each \$295.00



CENTRAL SCIENTIFIC CO.

1718-M Irving Park Road • Chicago 13, Illinois Branches and Warehouses — Mountainside, N. J. Boston • Birmingham • Santa Clara • Los Angeles • Tutas Mouston • Toronto • Montreal • Vancouver • Ottawa

### Letters

(Continued from page 1324)

try. Relative to the Atomic Energy Commission, the Public Health Service, or the Armed Services, it has been, however, starved of funds. I believe that the National Science Foundation is more likely to come into its own and receive the support it deserves if it is a part of a department of the government headed by an officer of cabinet rank.

The size of the research program of the United States Public Health Service is, of course, largely due to the intense interest of the public and of Congress in matters related to health, but I think the program has also been strengthened by the fact that the United States Public Health Service is part of the Department of Health, Education, and Welfare and has a cabinet officer with the departmental organization behind him to speak on its behalf. The actual function of the National Science Foundation, with respect to the support of scientific research, should involve support of research over a much wider area than that of the Public Health Service, since it includes the whole realm of fundamental research in the physical and biological sciences, with overlapping into the area of medicine and social sciences. I believe that the National Science Foundation will stand a better chance of growing to its proper stature as part of a federal department headed by an officer of cabinet rank than it would as a separate and isolated agency.

This criticism, of course, deals with only one aspect of Berkner's proposals, which in general I would endorse whole-heartedly. I hope that his powerful and convincing article will receive the attention it deserves from scientists throughout the country—and from the politicians.

JOHN T. EDSALL

Harvard University, Cambridge, Massachusetts

#### Philanthropy

I confess that I was jarred by the editorial, "How to be generous cheaply" [Science 129, 805 (1959)]. I am aware of the fact that many pleas for philanthropy are supported primarily by the argument that "you can deduct it from your income tax." But I had not expected the AAAS to be promoting a considered plan for the encouragement of such practice.

Basically, the editorial is an expression of distrust in the capacity of the Federal Government—which is all of us—to make wise expenditures of its tax receipts. Better, the editorial says, to create a condition in which each individual has increased latitude to decide for himself the social causes and institutions (privately operated and controlled) which he cares to support.

I believe such thinking is headed in the wrong direction. If we traveled far enough along this road, disaster could overtake us, Granted that the Government sometimes does not spend wisely, it does not follow that private, individual judgments in "giving" are certain to be formed in the public interest. Private philanthropy has often been irresponsible and wasteful.

Certainly, citizens should have reasonable encouragement to form and to support private, volunteer organizations for religion, education, and charity. But the primacy of the larger society should not be undermined. AAAS members should understand this principle better than any other group and not become just another pressure group out to shoot a few more holes in the income tax.

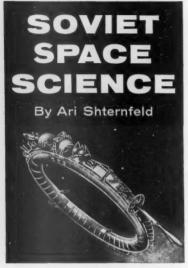
P. W. HUTSON

University of Pittsburgh, Pittsburgh, Pennsylvania



29

# The Russians' Own Story of Artificial Satellites



"Singularly free of propaganda . . . One of the best surveys of astronautics published in any country." WILLY LEY

Just published, this comprehensive new account of Russian theoretical and practical progress in the field of astronautics is written by a leading Soviet space scientist and now appears in English in the official U.S. Air Force translation. Here is the definitive history of the Soviet satellite program, with actual photographs, drawings, tables and technical data — much of it based on the author's own original research. Among the contents are: Plans for a Revolutionary "Fixed Star" Satellite, Construction of a Space Platform, Scientific Objectives of Space Flight, Design and Construction of Space Ships, Survival of Man in Space, Flights to

the Moon, Problems of Re-entry into the Earth's Atmosphere,



h I I I I	\$600
BASIC BOOK	(S, Publishers
SCIENCE by Ari Shte	shers
City	Zone
State SAVE POSTAG enclosing payme postage. Same re	E! Check here if you are nt now and we will pay eturn privilege.

## Meetings

Autoradiography

A conference on autoradiography, sponsored by the American Cancer Society and the National Cancer Institute of the National Institutes of Health, was held at the Westchester Country Club, Rye, N.Y., 22–24 Sept. 1958. Thirty-five leaders in the field were invited to a "retreat" conference. Twelve of the participants were from Great Britain, Sweden, Denmark, Belgium, and Canada; the others were from the United States. Twenty-five scientific papers were presented and discussed.

A day was spent on theoretical considerations and technique. R. H. Herz (Kodak Ltd., Harrow) reported that latent-image fading of photographic emulsions, particularly in the AR-10 stripping film so useful to the biologist, might be greatly reduced, and the speed of the film doubled, by exposing the emulsion in an atmosphere of very low humidity and devoid of oxygen. J. Spence (Eastman Kodak Co., Rochester, N.Y.) emphasized the desirability of doing experimental control studies in autoradiography to evaluate accurately latentimage fading. The problem of the production of tritium (H3) tracks in emulsion was discussed at some length.

Hilde Levi (Copenhagen) pointed out the quantitative validity of relative grain-counting and track-counting techniques but also the potential errors of these methods when G-5 liquid emulsion and C14 and S35 are used. I. E. Gullberg (University of California, Berkeley) emphasized the value of dark-field illumination for both the visual examination and the automatic, instrumental grain counting of autoradiograms. It was agreed that with this technique there is an increase in the number of visible events, both in the background emulsion and over the radioactive source, but there was no unanimity on the part of the discussants as to whether there was a gain or loss in signal-to-noise ratio.

W. Tolles (Airborne Instruments Laboratory, Mineola, N.Y.) discussed methods of automatic quantitation of autoradiograms. He indicated that the principles of the instrumentation used in the automatic scanning of Papanicolaou smears of exfoliated cells and utilized also in the design of a nuclear track scanner that counts the proton tracks in film badge emulsion might readily be applied to autoradiography. Practical difficulties such as a wide spread of density in a field or the overlapping of grains might become significant. S. Pelc (Kings College, London) reminded the group that the biologist in doing quantitative studies usually spends considerable time preparing his specimen and selecting the few areas that he wishes to measure. He raised the question of whether it is profitable to build large-scale grain-counting instruments inasmuch as only a small fraction of the work involved is that of grain counting.

Ho

plu

cen

dog

tra

Pu

but

pa

mı

La

the

lit

efl

or

E. Odeblad (Caroline Institute, Stockholm) gave a mathematical evaluation of the density of photographic emulsions by a matrix system. This interesting approach to problems of resolution and "cross-fire" dosimetry has not yet been evaluated in terms of the results that have already been achieved by

other techniques.

D. L. Joftes (Cancer Research Institute, Boston) discussed a technique in which fluid, nuclear-track emulsions are used with H3- and C14-labeled isotopes. Its chief advantage seems to be speed and ease of processing large numbers of autoradiograms. L. Bélanger (Ottawa) showed how autoradiography could be used as a histochemical tool by studying the uptake of Ca45 and S35 in bone sections that had been incubated in a medium containing the isotope. Differences in uptake of Ca45 in normal and pathologic bone were indicated by the autoradiograms. R. L. Swarm (National Cancer Institute, Bethesda) used the uptake of I131 and S35 in autoradiograms of thyroid and cartilage transplants as a measure of the viability of the transplant.

A morning session was devoted to radiation effects and radiation carcinogenesis. H. Lisco (Argonne National Institute, Chicago) illustrated the pathogenesis of lung cancers secondary to the inhalation of plutonium by concomitant histological changes and autoradiographic distribution of the isotope. The experimental lesions resembled the Joachimstahl lung cancers of man. L. Lamerton (Royal Cancer Hospital, London) discussed the problems of dosimetry in evaluating radiation-induced bone cancers and pointed out the wide range of possibilities for the production of focal injury and subsequent carcinogenesis. The microscopic distribution of isotopes can be determined by thicksection autoradiography, and there is great need for this type of approach which, in combination with an assessment of histologic damage, is so important to the unraveling of problems in carcinogenesis.

Janet Vaughan (Oxford) discussed autoradiography and dose-rate measurements in bone and showed a correlation between the different types of damage observed and the different patterns of dose rate and total dose received in the tibia of rabbits receiving Sr<sup>90</sup>. Bone tumors arose in the areas of maximum dose or maximum damage after intravenous injection. In the animals fed Sr<sup>90</sup>, the site of origin of tumors appeared to be generalized in association with the more generalized distribution

of maximum dose.

J. Arnold (Veterans Administration Hospital, San Francisco) showed that plutonium (Pu<sup>239</sup>) is more diffusely concentrated in the lung and flat bones of dogs. With time and remodeling of bone traveculae and at certain dosages of Pu<sup>230</sup> the distribution is more diffuse and tends to resemble the Ra<sup>226</sup> distribution. Dziewiatkowski (Rockefeller Institute) showed by autography the decreased uptake of S<sup>35</sup>-sulfate in the epiphyseal plate of the tibia of the mouse after radiation.

An afternoon session was devoted to papers on nucleic acid, protein, and mucopolysaccharide metabolism. L. G. Lajtha (Oxford) pointed out many of the disadvantages of the tritium label in nucleic acid studies, in particular its radiation effects. There was considerable disagreement about the matter, the Brookhaven group being less convinced of the effect. All agreed that relatively little was known about many features of tritium, especially about its radiation effect.

S. Pelc (London) stated that the percentage of cells concentrating thymidine-H³ is higher in many systems than the known rates of mitosis would lead one to expect. He concluded that deoxyribonucleic acid (DNA) metabolism might occur independently of any replication activities and have a turnover distinct from mitotic activities. There was considerable discussion about whether mitotic rates were as low as Pelc assumed or whether mitosis occurred as infrequently as he believed.

A. Ficq (Free University of Brussels) indicated that protein synthesis occurred in the salivary gland chromosomes of dipteran larvae and that there were areas of the chromosome which incorporated tritiated thymidine in high concentrations at certain stages of larval life.

I. Tessman (Massachusetts Institute of Technology) reported on the "star" technique of studying bacteriophage multiplication by pouring emulsion plates containing P82-labeled DNA in bacteriophage particles. He compared the number of "stars" in parental T2 phage with the number of "stars" in progeny resulting from the parental phage growth in bacteria, lysis of the bacteria, and the release of progeny phage. This technique shows that some progeny phage contain 20 percent as much DNA as the parental phage. The significance of this approach in terms of knowledge concerning the replication of DNA, as well as its importance in virus metabolism, were pointed

G. Asboe-Hansen (Copenhagen) used S<sup>35</sup>O<sub>4</sub> and the Rous sarcoma to show that the mast cell, nongranulated meta-chromatic cells, and the extracellular ground substance incorporate S<sup>35</sup>. Autoradiograms indicate that the mast cell is

# High-speed precision balance saves time in research





# **SHADOGRAPH®**

gives fast, positive stop reading ...eliminates parallax

Model 4142 Shadograph is recommended for weighing cancer tissue and tumors. Fully-enclosed weigh pan, easily removable for sterilization, is readily accessible through a clear plastic door. Unaffected by air currents. Weight indication by a light projection system gives fast, precise reading. Operates on 110 volts, 60 cycles. Rated capacity 15 grams; visible sensitivity to 5 milligrams. Movable dial viewer for 5 rows of graduations, each row 3 grams by 5 milligram graduations. Weight range selector has 5-notch beam corresponding to dial chart. Write for complete data and specifications.

#### SMALL ANIMAL BALANCE

Model 4203B-TC-SA recommended for fast, precise weighing of mice, chicks, frogs and small rats. Dial graduated in two columns: 0—30 grams and 15—45 grams in increments of 0.5 gram. Dial shutter with outside control to close off dial column not in use. Beam 100 grams by 1 gram. Other models up to 3 kilos, 350 milligram sensitivity for rats, hamsters and guinea pigs.



#### CENTRIFUGE BALANCE

Model 4206B-TC also for general laboratory use and small-animal weighing. Has tare control knob to zero the dial, or position for over-and-under reading. Capacity 3 kilos; sensitivity to 350 milligrams. Dial is graduated 0-100 grams in increments of 1 gram. Beam 500 grams by 5 grams.



## THE EXACT WEIGHT SCALE CO. 901 W. FIFTH AVE., COLUMBUS 8, OHIO

In Canada: 5 Six Points Road, Toronto 18, Ont.

Sales and Service Coast to Coast





ie

not necessarily the origin of extracellular sulfomucopolysaccharides.

One session was given to tritium-labeled isotopes. C. P. Leblond (Mc-Gill) used thymidine-H3 as an indicator of the replication rate, and he divided cells of the body into three groups on the basis of the percentage of cells labeled after the injection of thymidine-H3. In his study, the cells that turned over the thymidine-H3 most rapidly were found to be those of the skin, the thymus, and the gastrointestinal tract. The cells that responded most slowly were those of the central nervous system and muscle. Activity for most other organs was between these limits.

E. Cronkite (Brookhaven National Laboratory, Upton, N.Y.) presented data on the life-cycle time determination, DNA synthesis, and the turnover of cells in the reticuloendothelial and marrow cells. The Brookhaven group emphasized that the percentage of labeled cells in an organ after a single, rapid injection of labeled thymidine is equal to the percentage of the total cell lifetime devoted to DNA synthesis. If DNA synthesis is assumed to be a prelude to division, a high percentage of labeling indicates that a large percentage of cells is preparing to divide. These investigators believe that there is a widespread pool of primitive progenitor mesenchymal cells which is continually migrating and appears able to respond to many types of stress leading to repair,

defense, or regeneration.

R. Painter (Brookhaven) used tritiated thymidine to determine subdivisions of the lifetime cycle of HeLa cells in tissue culture. W. Plaut (University of Wisconsin) raised questions about the damage to chromosomes caused by thymidine-H3 and the effect upon conclusions drawn from tritium replication studies. In rebuttal, Taylor (Columbia) stated that the percentage of intrachromosomal changes and exchanges between sister chromatids of Bellevalia after irradiation did not increase in succeeding generations, thereby implying that since increasing exposure to radiation did not bring about an increase in radiation effects, the radiation effect was not great.

P. Woods (Brookhaven) showed that in plant cells cytidine-H3 was quickly taken up in ribonucleic acid (RNA) of the nucleoli. When the cells were removed from a radioactive medium where they had been kept for a short period to allow for nucleolar labeling and placed in a nonradioactive medium to permit growth to continue, autoradiograms of the cells after some hours showed the label in the RNA of the cytoplasm. P. I. Fitzgerald (State University of New York, Brooklyn) showed that in the rat the tritium of cytidine-H3 was localized in the nucleolus of the pancreas acinar cells half an hour after injection, and at 24 hours was predominantly cytoplasmic. These two studies suggest that some RNA, or a portion of the RNA molecule, of the nucleolus passes into the cytoplasm.

The chairmen of individual sessions pointed out in summary the need for further parallel studies of radiation effect with respect to histologic damage, isotope localization, and dosimetry. They urged study of the range, absorption, and grain yield of tritium in photographic emulsions. Particularly emphasized was the lack of knowledge concerning the radiation effect of tritium on cell metabolism and replication. This was deemed most important in studies of such substances as tritiated thymidine, which concentrates in the DNA. The great value of tritium in cellular resolution warrants further study of these aspects of its use. It was emphasized that greater employment of biochemical techniques in conjunction with autoradiographic studies was desirable. The value of quantitative studies was reemphasized, but limitations and technical difficulties were noted.

EXCLUSIVE WITH :

### NEW ENGLAND NUCLEAR

LARGEST PRODUCER OF RADIOCHEMICALS

### CARBON-14 LABELED STEROIDS

NEC-163 Hydrocortisone-4-C14

NEC-155 Cortisone-4-C14

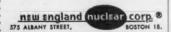
NEC-115 Desoxycorticosterone-4-C14

NEC-127 Estradiol-17β-4-C14

NEC-148 17a-Hydroxyprogesterone-4-C14

Information on these and other steroids on request.

NEW 1959 CATALOG ON REQUEST





# STUDENT ICROSCOPES

Most reasonably priced GUARANTEED Microscope on the market.

Made in West Germany

NEW DESIGN **EXCLUSIVE** SAFETY FEATURES HIGH QUALITY OPTICS 10X OCULAR **OBJECTIVES** 16mm (10X) N.A. 0.27

4mm (44X) N.A. 0.66 plano/concave mirror

STILL \$118.00 TEN YEAR GUARANTEE

> Write for catalogue listing safety features

10% Discount on 5 or more Models may be assorted to obtain this discount

TRANSPORTATION



THE GRAF-APSCO CO. CHICAGO 40, ILL 5868 BROADWAY

## FOR PAPER CHROMATOGRAPHY-

A NEW & SIMPLE METHOD OF CHROMATOGRAPHING PAPER STRIPS

#### The New Kurtz-Miramon Technique



ır

r

ie

19

or f-

d

ic

ne.

as

of

ie,

he

IS-

at h-

ue

ed,

...permits chromatographing large numbers of paper strips at one time in a small space.

...eliminates fumbling with dangling, wet paper strips.

...prevents papers from touching or rubbing together while being developed, washed, sprayed, and dried.

...eliminates use of anchor and anti-siphon rods.

...utilizes all-glass apparatus.

Write for Brochure SK

CALIFORNIA LABORATORY EQUIPMENT CO98 Rincon Road Berkeley 4 California



# GYROTORY® Water Bath Shaker

A variable speed, rotary shaking apparatus integrated with a constant temperature bath... precision built for continuous duty.

Model G76

- Variable speed control from 85 to 285 rpm.
- $\bullet$  Heats rapidly to pre-set temperatures from ambient to 100° C.  $\pm$  0.5° C.
- Triple eccentric stabilizing system assures uniform agitation to all flasks on shaking platform.
- Continuous duty. Cool, quiet, vibrationless performance.
- Compact, large capacity. Used with gaseous atmospheres.

UNCONDITIONAL 1 YEAR GUARANTY

Write for catalog G76-S515



NEW BRUNSWICK SCIENTIFIC CO.

PRECISION LABORATORY

P. O. BOX 606 . NEW BRUNSWICK, N. J.

\* completely unobstructed

\* easily accessible from all sides.

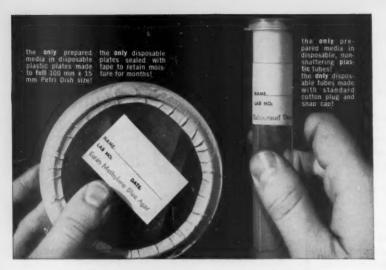
# METTLER PRECISION SCALES HAVE THE PAN ON TOP...

- completely unobstructed
- easily accessible from all sides.

METTLER precision scales are highly versatile instruments. Calibrated in either grams, pounds, ounces, pennyweights or grains and equipped with taring device, they are the modern balance for a great variety of uses.

Write today for your complete file on METTLER scales and balances

METTLER INSTRUMENT CORPORATION
BOX 242, HIGHTSTOWN, NEW JERSEY



now! for faster, more accurate fungal and bacterial diagnosis...

# disposable, *standard size,* non-shattering plastic plates and tubes with prepared culture media

Save technicians' valuable time for productive use! Save space now being wasted to stock unusual formulae! Get accuracy of standardized formulae... convenience and speed of sterile, ready-to-use prepared culture media, many of them

exclusive with Media, Inc.l 14 fungal culture media, 34 bacterial culture media, new cystic fibrosis test agar—all in disposable plastic containers that eliminate glassware washing, breakage!

| PRICE SCHEDULE | Number of a kind | Price per tube | Price per tube | Price per tube | Price | Price per tube | Price | Price per tube | Price | Pri

of stock formulae, write for com-

The EMIL GREINER Co. 20-26 N. MOORE STREET DEPT. 245, N. Y. 13, N. Y.



weight • space • power • costs

Eastern has
just the right
pumps or mixer for
your laboratory or pilot
plant application. The wide
range of Eastern products lets
you choose standard units so
closely geared to the job that
they might have been created
just for it.

A complete engineering service to help you, and a big selection of more compact, versatile, high performance pumps and stirrers—this is the formula for your quick and easy choice.

Send for laboratory equipment bulletin No. 1540



lab use.

# EASTERN INDUSTRIES, INC.

In the attempt to avoid delay in the publication of the proceedings of the conference, a stenotypist recorded the discussion, and each participant, within a few hours after his remarks, was given a typewritten copy of them for correction. Through this arrangement and the prompt submission of papers by participants, publication of the papers and discussion in the January–February 1959 issue of Laboratory Investigation—4 months after the conference—was made possible.

pfla

Ger

Uni

Lan

Par

Scie

gan

Mo

lane

non

Fra

gew

N.

dor

dor Aus

Da

Me

ver

and

Ge

wri

cal

Ph

spe

po

log

tri

pa

uc

Li

In

ra M

an

R

ra

is

th

fii

PATRICK J. FITZGERALD
State University of New York, Brooklyn

#### American Heart Association

Forms for submitting abstracts of papers intended for presentation at scientific sessions of the American Heart Association in Philadelphia, Pa., 23–25 October, are now available from Dr. F. J. Lewy, Assistant Medical Director, American Heart Association, 44 E. 23 St., New York 10, N.Y. Applications for space for scientific exhibits may also be requested from Lewy. Both abstracts and applications for exhibit space must be postmarked no later than 12 June. Space for industrial exhibits may be requested through Steven K. Herlitz, Inc., 280 Madison Ave., New York 16, N.Y.

This year for the first time the scientific sessions will include a joint program with the American College of Cardiology. The college, holding its eighth interim meeting concurrently, will conduct "fireside conferences" on the evening of 23 October in which AHA members will participate. On 25 October a panel on Cardiac resuscitation will be presented jointly by the college and the association's council on clinical cardiology.

#### **Cold Spring Harbor Symposium**

The 24th annual Symposium on Quantitative Biology will be held at the Long Island Biological Laboratory, Cold Spring Harbor, N.Y., 3–10 June. As part of its policy of fostering a closer relation between biology and other basic sciences, the laboratory each summer invites a group actively interested in a specific aspect of quantitative biology, or in methods and theories applicable to it, to take part in a symposium.

The topic this year will be Genetics and 20th Century Darwinism. Research findings will be presented during 16 sessions. Presiding over the opening session on the evening of 3 June will be I. M. Lerner of the University of California. Ernst Mayr of Harvard University will present the opening paper.

Participants from abroad will include: Hans Stubbe of the Institut for Kulturpflanzenforschung, Gatersleben, East Germany; A. A. Buzzati-Traverso of the Universita di Pavia, Pavia, Italy; M. Lamotte, Ecole Normale Superieure, Paris; F. H. W. Morley, Commonwealth Scientific and Industrial Research Organization, Canberra, Australia; A. E. Mourant, Lister Institute, London, England; L. L. A. Coutinho, Estacao Agronomica Nacional, Lisbon, Portugal; Franz Schwanitz, Staatsinstitut für Angewandte Botanik, Hamburg, Germany; N. A. Barnicot, University College, London; P. M. Sheppard, University of Liverpool, Liverpool, England; F. Ehrendorfer, University of Vienna, Vienna, Austria; B. Kurten, University of Helsinki, Helsinki, Finland; G. Heberer, Universitat, Göttingen, Germany; Pierre Dansereau, University of Montreal, Montreal, Canada; S. Smith-White, University of Sydney, Sydney, Australia; and B. Rensch, Universitat, Munster, Germany. For additional information, write to: Dr. Arthur Chovnick, Biological Laboratory, Cold Spring Harbor, N.Y.

#### **Pharmaceutical Companies Aid International Physiological Congress**

As it has done in the past, the American pharmaceutical industry has responded to a request for financial support of a triennial International Physiological Congress; this one, the 21st, is to be held in Buenos Aires, Argentina, 9-15 August.

The following companies have contributed: Burroughs Wellcome & Company, Inc.; Ciba Pharmaceutical Products, Inc.; Hoffmann-La Roche, Inc.; Eli Lilly & Company; Merck & Company, Inc.; Merrell-National (Overseas) Laboratories; Miles Laboratories, Inc.; Olin Mathieson International Corporation and the Squibb Institute for Medical Research; Smith, Kline & French Laboratories; and the Upjohn Company. The total amount is \$8100.

This assistance is particularly significant because the forthcoming congress is both the first to be arranged in one of the South American Countries and the first to be held under the auspices of the International Union of Physiological Sciences.

#### **Nuclear Society and** Atomic Industrial Forum

The American Nuclear Society and the Atomic Industrial Forum have announced plans to conduct a series of coordinated meetings. The two organizations are the largest in the country concerned exclusively with nuclear energy and radiation.

These meetings are planned to bring



The model LRA is the first automatic refrigerated centrifuge of its kind. Like the non-automatic Model LR, it has the newest and most efficient refrigeration design ever introduced. By proper placement of cutouts, baffles and deflection plates, a smooth forced air circulation system is set up. The warm air coming off the rotor flows around large surface area cooling coils on the side and bottom of the chamber. Upon emergence in the cooled form, the air flows onto all portions of the rotor. This system permits the cooling of any form, the air flows onto all portions of the cotor. This system permits the cooling of any courdes' rotor from ambient to 0°C within ten minutes by spinning at slow speed. Rotor temperatures are easily maintained at 0°C and lower during full speed extended runs, and as low as —15°C at lesser speeds or for shorter runs.

for shorter runs.

By merely throwing a toggle switch, a 1 Hp. motor automatically accelerates any rotor to a pre-set speed. Lourdes' electrodynamic pushbutton braking system provides for smooth rotor stopping in a fraction of unbraked stopping time. A time delay relay releases the braking action at slow speed and permits the rotor to stop naturally without disturbing the sediment. This same centrifuge is now available with a ½ Hp. motor drive (Model LRA-1) to provide higher speed and force with the smaller rotors. maller rotors

smaller rotors.
Each centrifuge comes adapted to accommodate the new Lourdes' continuous flow system at no additional cost. The continuous flow rotors with polyethylene liners, in addition to ease of operation, assembly and disassembly, also offer fast flow rate, high speed and force and greater collection capacity than any comparable continuous flow centringe. New time saving applications for these rotors are being discovered daily.

Every Lourdes' instrument is guaranteed for a period of one year and this guarantee insures customer satisfaction.

LARGEST MANUFACTURER OF SUPER-SPEED CENTRIFUGES. ESTABLISHED 1944

**Automatic** Super-Speed

# REFRIGERATED CENTRIFUGE

- \* Fully automatic rotor acceleration
- \* Push button Electro-Dynamic Braking (smooth stopping)
- \* Accommodation for new continuous flow system\*
- \* Automatic unbalance Electrical Safety
- Accommodates new 3 liter capacity rotor (10,000 X G)
- \* All Lourdes' rotors directly interchangeable
- ★ Unsurpassed refrigeration efficiency
- \* Electric tachometer and synchronous
- \* Complete safety controls

Write for New General Catalog refer to S-59

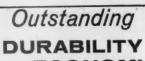
#### Catalog includes:

- Refrigerated centrifuges\*
- Non-Refrigerated centrifuges
- Automatic Centrifuges
- Non Automatic centrifuges
- Continuous flow centrifuges\*
- Rotor and accessories
- · Multimixer-All purose homogenizer
- Volumixer—Large capacity homogenizer

Sole distributor in Canada Canadian Laboratory Supplies Ltd. also Nationwide U.S.A. Dealerships

## **LOURDES Instrument Corp**

BROOKLYN 32, NEW YORK



and ECONOMY

OF DURA-VAC®

PLASTIC\* DESICCATORS



Height 71/2"; Flange Width 34"; Inside Dia. 634"

## IDEAL FOR STUDENT USE AND GENERAL ANALYTICAL WORK!

GUARANTEED FOR ONE YEAR
AGAINST ACCIDENTAL BREAKAGE

#### STRONG

Because of its Spherical Surface, Dura-Vac presents maximum strength in deflection of impact blows. Tough Plexiglas virtually eliminates breakage from accidental dropping.

#### FEATHER-WEIGHT

Weighs only a fraction of comparable size glass unit. Can be lifted and carried about with ease.





Height 14"; Dia. 13"; Inside Dia. 10" SELF-RELEASING LID

No longer need you struggle to pry off lid "frozen" to the bottom by evacuation.

#### UNIQUE STOPCOCK

Upward Vents prevent returning air from disturbing contents.

Ask Dept. DV- E to send you Bulletins Nos. 5810 and 5815

\*Fabricated of Plexiglas, a trade named product made by Rohm and Haas Company.

ACE GLASS VINELAND & NEW JERSEY

Midwestern Division
LOUISVILLE, KY.—Box 996

into focus the latest developments in both the technical and business phases of the peacetime uses of the atom. Independent sessions covering these two different aspects of nuclear science are planned. A partial overlapping of the meeting schedules of the two organizations is intended to be a constructive step toward the avoidance of duplicate travel.

The American Nuclear Society, founded in 1954, has a professional membership of around 3000 from all branches of nuclear science and technology. The Atomic Industrial Forum is a nonprofit membership association of more than 500 industrial and other business organizations, research and service companies, labor groups, and educational institutions engaged in the development and utilization of nuclear energy for constructive purposes.

Present planning includes coordinated meetings in the fall of 1959 in Washington, 1960 in San Francisco, and in 1961 in New York. Both organizations will continue to hold additional individual meetings throughout the year.

#### **Isotope Effects**

Argonne National Laboratory will conduct a conference on isotope effects in chemistry and biology on 8–9 June. The conference, sponsored jointly by the divisions of chemistry and of biological and medical research, will present a program of 14 papers concerned with the effects of isotopic substitution on chemical and biological processes. Further information may be obtained by addressing Miss B. Litt, Isotope Effects Conference, Argonne National Laboratory, P.O. Box 299, Lemont, Ill.

#### Symposium on Electrolytes

The program of the Trieste congress of the Societa Italiana per il Progresso delle Scienze, 4–9 June, will include a symposium on electrolytes. P. Debye of Cornell University will be honorary chairman of the symposium and opening speaker; the program chairman is professor Raymond M. Fuoss of Yale University.

#### Colloquium of College Physicists

The 21st annual Colloquium of College Physicists and the Associated June Lectures will be held at the State University of Iowa, Iowa City, 17–20 June. The program will consist of lectures on developments in contemporary physics and round-table discussions on the teaching of physics and on other current problems of the profession. One evening will be devoted to the exhibit of original

demonstration equipment and other teaching devices prepared by the participants.

The Associated June Lectures will be given by Thomas Gold, professor at Harvard College Observatory, on magnetic fields and particles in the solar system and on large-scale structure of the universe.

Registration is without fee. The colloquium is assisted by the National Science Foundation.

#### **Electron Microscopy**

The 17th annual meeting of the Electron Microscope Society of America will be held 9-12 September at Ohio State University, Columbus. Special attractions of the meeting include symposia on the contributions of electron microscopy of viruses and cells to the problem of cancer, elementary techniques of electron miscroscopy from the point of view of experts, and problems in the electron microscopy of ceramic materials. Information concerning the meeting may be obtained from: Sydney S. Breese, Jr., program chairman, EMSA, Plum Island Animal Disease Laboratory, Greenport, N.Y. The deadline for 150-word abstracts of contributed papers is 1 June.

#### **Embryology**

The editorial board of the Journal of Embryology and Experimental Morphology is sponsoring the fourth of its series of international embryological conferences at the College de France, Paris, from 21–24 September. Details of its organization and scientific program will be available on 1 June and can then be obtained from Prof. E. Wolff, Laboratoire d'Embryologie Experimentale, 49 Avenue de la Belle Gabrielle, Nogentsur-Marne, France, or from Dr. L. Brent, Department of Zoology, University College, Gower Street, London, W.C.1, England.

#### **Geology Teaching**

Thirty school science teachers and professional geological scientists from all parts of the country will participate in a 6-week conference at the University of Minnesota, Duluth, from 20 July to 28 August, to prepare improved materials for the teaching of geology in school science programs. The Duluth conference, which is being sponsored jointly by the American Geological Institute and the University of Minnesota, Duluth, is a part of a broad and continuing program of public education by the institute. The conference is being conducted with the financial assistance of

Excellen

G C A

# New design for freeradical production

RAYTHEON'S 800-WATT POWER **GENERATOR ON** FCC-ALLOCATED **FREQUENCY** 2,450 Mc.



Raytheon Manufacturing Company	V
Industrial Apparatus Division	
Power Generator Dept. C5	
Waltham 54, Massachusetts	

Please send the following Power Generator material:

- Complete specification sheet
- Article reprint, "Frozen Free Radi-cals," Scientific American, March,

Comprehensive raphy	application	bibliog
---------------------	-------------	---------

Name	
 Address	
City	

1376a

n.

## Readers' Service

## Information Requisition

Use the bottom postcard to obtain further information about items described in advertisements and in the New Products columns. This card is good for 2 months only.

Advertisements. Circle the number of the page on which ad appears, U, upper ad; M, middle ad; L, lower ad; I, inside ad; O, outside ad. If more than one item appears in an ad, indicate at the bottom of the card which item is of interest; otherwise the request cannot be processed.

New Products. Circle the number corresponding to the number given at the end of each paragraph in the New Products columns (pages 1386-1389).





## BUSINESS REPLY MAIL FIRST CLASS PERMIT NO. 31125, WASHINGTON, D. C.

American Association for the Advancement of Science 1515 Massachusetts Avenue, N.W. WASHINGTON 5, D.C.

Roadors	iders' Service		15	15 May 1959			Print name and address on front of card.	
Advertis	ements							
IFC	1307	1308	1309	1310	1313	1314	1316	1317
1318	1319	1320	1321	1323	1324	1325	1326	1328
1368, UO	1368, UI	1368, LO	1368, LI	1369	1370	1371	1372, LO	1372, LI
1373, UI	1373, UO	1373, L	1374, U	1374, L	1375	1376	1376a	1376b, UI
1376b, LI	1377	1378	1379, 1	1379, 0	1380,0	1380, 1	1381	1382, 0
1382, 1	1383, U	1383, L	1384	1385, UI	1385, UO	1385, L	1386, 0	1386, UI
1387	1388	IBC	OBC					-

793	799	802	804	807	809	811	812	813	814
815	816	817	818	819	820	822	823	824	825
826	827	829	831	832	833	834			

Item of Interest in ad -

## SUPPLIES AND EQUIPMENT

|Rats from the Wistar Strain |

Pigs Guinea **Laboratory Animals** 

since 1929 ALBINO FARMS, PO Box 331 RED BANK, NEW JERSEY

Swiss Mice - Albino Rabbits

Gas Chromatography

FREE Subscription to AERO - GRAPH Research Notes, a technical publication on new develop chromatography. We offer a cor of essential supplies and the of GLPC equipment.

Send for your free subscrip WILKENS INSTRIBUTED

or GLPC equipment.

Send for your free subscription today
WILKENS INSTRUMENT & RESEARCH INC.

Box 323, Wainut Creek, California YEllowstone 5-1469

Do You Need: -

Address

City

Zone

Signature

Cellex Cellulose Ion Exchangers?

(For fractionation of proteins, nucleic acids, and enzymes)
ASK FOR PRICE LIST SCX

\*BIO·RAD Laboratories 32nd & GRIFFIN AVE . RICHMOND, CALIFORNIA

ş

Send to this new member and bill me for \$8.50.

D

gift card

3

CITY

Zone

BOOKS AND MAGAZINES

Your sets and files of scientific journals

are needed by our library and institutional cus-tomers. Please send us lists and description of periodical files you are willing to sell at high mar-ket prices. Write Dept. A3S, CANNER'S, Inc. Boston 20, Massachusetts

PROFESSIONAL SERVICES

FOUNDED 1922

Food and Drug Research Laboratories

Maurice Avenue at 58th Street Maspeth 78, New York City CABLE: FOODLABS TEL. TWINING 4-080

Name

PUBLISHER • Early publication
• High reputities

Guarantees
• Free sales analysis
• Free differior assistance
• Fine quality books
• Substidy financing

Fiction or non fiction manuscripts accepted Free brochure, SM6, on our publishing plan

ASPEN PRESS 1106 N. Weber Colorado Springs, Colo.

70

AAAS:

addressed to: (please print)

SCIENCE at \$8.50

for one

year Subscripð

Please enter a Membership

long to be appreciated

SCIENCE with AAAS Membership GRADUATION CIFT

FIRST CLASS

**PERMIT NO. 12711** HEW YORK, N.Y.

BUSINESS REPLY MAIL

No postage stamp necessary if mailed in the United States

- Postage will be paid by -

SCIENCE MAGAZINE

**Room 740** 11 West 42 Street New York 36, New York



romicron

DEPRESSION SLIDE



ONE PIECE **PYREX** FLAT DEPRESSION

> Ground and polished Can easily be sterilized

> > Specially designed

for

TISSUE CULTURE PHASE CONTRAST MICROSCOPY

write for pamphlet S-559

PAUL ROSENTHAL 505 Fifth Avenu

New York 17, N. Y.

## PROPIPETTE



• Time Tested • No moving parts

• Time Tested • No moving parts
• Simple to operate

The new PROPIPETTE eliminates the dangerous practice of using the mouth to draw liquids into pipettes. It is simple to use and the operator soon becomes proficient so that liquids can be delivered quickly, precisely and safely. Measurement precision is extremely high (0.01cc). The instrument has three agate-ball valves which operate independently and the entire procedure can be done with only one hand.

PRICE \$6.90 each . . . comes in black, red, green and blue, sent on approval.

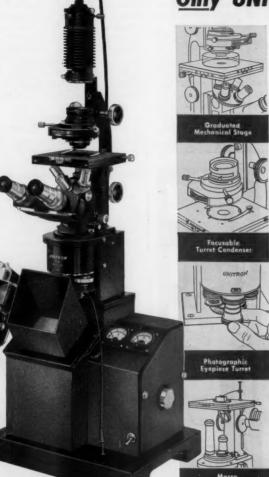
all laboratory pipettes can be used with the PROPIPETTE—Safety Pipette Filler.

Write for additional information INSTRUMENTATION ASSOCIATES

Distributors of Laboratory and Scientific Specialties

New York 23, N.Y.

## In a PHASE-CAMERA-MICROSCOPE Only UNITRON offers all three:



**✓** CONVENIENCE VERSATILITY / FCONOMY

UNITRON'S unique Phase-Camera-Microscope will assure you a CONVENIENCE of operation impossible to duplicate with a conventional microscope stand. For example, a specimen consisting of a tissue culture or aqueous solution may be examined in the very petri dish in which it has been prepared. Merely place the dish on the microscope stage; examine the contents visually, project the image on the viewing screen, or photograph — all in rapid sequence and at magnifications up to 2000X. With the inverted design, there is no need to contend with slipping cover glasses or evaporating fluids. Using the phase optics, you dispense with messy chemical staining. Aided by the self-contained illumination system and built-in cameras, you eliminate troublesome problems of alignment and vibration.

UNITRON'S Phase-Camera-Microscope, optically equipped for Bright and Dark Phase Contrast, bright and dark field, and polarized light, offers the microscopist a working tool of unmatched VERSATILITY. The overhead turret phase condenser is centerable, divisible, and provides long working distances sufficient even for micro-manipulation. Provision is included for four different cameras - 314" x 4 1/4", 35mm., Polaroid, and motion picture. Available at extra cost are macro accessories for magnifications as low as 5X and accessories for opaque specimens. This UNITRON model meets not only your urgent needs of today — its versatility is your assurance of continued usefulness in the future.

UNITRON'S Phase-Camera-Microscope is the ideal allpurpose instrument for visual examination, viewing, and photo-recording. Completely equipped with an impressive array of optics, its cost is actually lower than that of a conventional phase stand, camera and illuminator - true **ECONOMY** for any laboratory.

Visual Eyepieces







UNITRON'S Phase-Camera-Microscope Model BU-13 as described including binocular body; 8 phase objectives 10%, 20%, 40%, 100% oil, in both bright and dark contrast; paired visual eyepieces 85%, P10%, Ke15%; focusing telescope; four photographic eyepieces 10%, 15%, 20%, Micrometer; phase condenser; filters; polarizing accessories; special glassware, etc.

Monocular Model U-13

\$1390

204-206 MILK STREET . BOSTON 9, MASSACHUSETTS

Please rush UNITRON's Microscope Catalog 4Q-3

THE TREND IS TO UNITRON

15 MAY 1959

TES

the National Science Foundation. Robert L. Heller, associate professor and head of the geology department on the Duluth campus, has been selected by AGI to serve as director for the conference.

The conference will open with an orientation period of several days, after which the science teachers and geoscientists will be organized into small groups to consider specific problems. Under Heller's guidance, existing geology teaching materials now are being assembled, inventoried, and classified in advance of the summer session. These

will be evaluated and supplemented by the conference. The materials produced and evaluated during the Duluth program will be tested, reviewed, and revised following the conference prior to distribution.

## Vascular Disease

Leaders in vascular medicine and surgery will meet in Atlantic City, N.J. on 5-7 June, at the World Conference of Angiology, sponsored by the American College of Angiology and the Angiology Research Foundation. The conference will honor the tenth anniversary of the journal, *Angiology*, and the Angiology Research Foundation, and will mark the first time that an international meeting devoted exclusively to vascular disease has been held in the United States. Participants will come from Europe, Asia, South America, and North America.

David B. Allman of Atlantic City and Thomas W. Mattingly, U.S. Army Medical Corps, have been elected as honorary cochairmen of the conference. Alfred Halpern, president of the Angiology Research Foundation, Saul S. Samuels, editor-in-chief of Angiology, and Paul S. Lowenstein, president of the American College of Angiology, will be the chairmen for the meeting.

The overseas speakers will include: Gunnar Bauer (Sweden), Rene Fontaine (France), George Arnulf (France), H. Paessler (Germany), Max Hochrein (Germany), Edmondo Malan (Italy), Alex Dimtza (Switzerland), Kaindle (Austria), A. M. Boyd (England), Hans Selye (Canada), and Alfonso Albanese (Argentina).

A dinner and reception will be held on 6 June, when Charles Mayo of the Mayo Clinic will be the principal speaker. For further information, write to the World Conference on Angiology, 11 Hampton Court, Great Neck, N.Y.

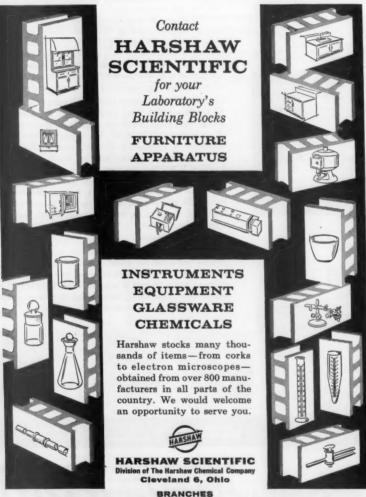
### Rheumatic Diseases

Leading rheumatologists and investigators from the Western Hemisphere will report their latest findings to the second Pan-American Congress on Rheumatic Diseases, 2–6 June, in Washington, D.C. Some 88 papers will be presented during the plenary sessions on 3 and 4 June at the main auditorium of the Clinical Center, Bethesda, Md., and during the concurrent sessions, 5 and 6 June, at the Hotel Mayflower.

The congress will be officially opened by Christian A. Herter, Secretary of State, at the Pan-American Union Building on the evening of 2 June. Arthur S. Flemming, Secretary of Health, Education and Welfare, will also speak that evening.

## Clay Conference

The eighth National Clay Conference will be held at the University of Oklahoma, Norman, 12–14 October, under the auspices of the clay minerals committee of the National Academy of Sciences–National Research Council. Symposia of invited papers will be held on the clay-and-water systems and on geochemical prospecting for clay minerals. In addition to these special symposia, there will be general sessions of con-



CLEVELAND 6, OHIO 1945 East 97th Street Tel. VUlcan 3-2424 CINCINNATI 13, OHIO 6265 Wiehe Rd. Tel. REdwood 1-9100 BRANCHES DETROIT 28, MICH. 9240 Hubbell Avenu Tel. Vermont 6-6300

LOS ANGELES 22. CALIF.

3237 So. Garfield Ave. Tel. RAymond 3-3161

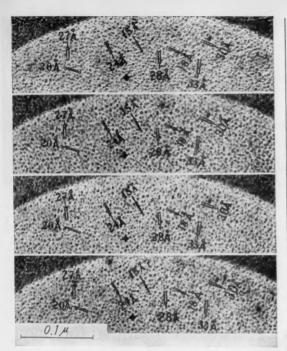
PHILADELPHIA 48, PA.

Jackson & Swanson Sts. Tel. HOward 2-4700

HOUSTON 11, TEXAS 6622 Supply Row Tel. WAlnut 3-1627

SALES OFFICES

AMARILLO, TEXAS, 3409 S. Jackson Street • ATLANTA S, GEORGIA, 3130 Maple Drive, N.E., Tel. CEdar 3-3560
BATON ROUGE 6, LOUISIANA, 3160 Florida Street, Deherty Building, Reem 103, Tel. Dickens 3-1933 • BUFFALO 2,
NEW YORK, 260 Delaware Avenue, Tel. GArfield 9-2000 • HASTINGS-ON-HUDSON 6, NEW YORK, Tel. HAstings
5-8250 • OAKLAND 11, CALIFORNIA, 3826 Piedment Avenue, Tel. Olympic 5-6511 • PITSBURGH 22, PA.,
504 Bessemer Building, 6th St. & Fort Duquesne Boulevard, Tel. ATlantic 1-7930



he gy he ng ase ar-

or-Al-

els,

de: de: one), rein y), dle ans

the

ipal rite

gy,

esti-

here

the

heu-

ing-

pre-

on 3

n of

and

nd 6

ened

y of

uildir S.

luca-

that

ence

Okla-

nder

com-

Sci-

Symd on

geo-

erals. oosia,

con-

L. 129

Evaporated palladium platinum on collodion film, Magnification: X 400,000.

# BENDIX ANNOUNCES NEW ELECTRON MICROSCOPE

Precision performance at moderate cost with the

## BENDIX TRONSCOPE

The Bendix Tronscope is as easily operated as an optical microscope . . . your research technician can obtain excellent results rapidly and repeatedly. The lens axis is optically aligned and fixed at the factory, eliminating the need for axis adjustment. This design reduces the time and skill required to obtain high resolution.

This unique design allows volume production of quality photomicrographs well within the guaranteed 20 Angstrom resolution . . . at a system price of less than \$18,000. For complete information and factory demonstration, contact the Cincinnati Division, Dept. E5, 3130 Wasson Road, Cincinnati 8. Ohio.

#### SPECIFICATIONS

Resolution: 20 Angstrom units guaranteed.

Direct Magnification: 1200X—30,000X continuously variable during operation; 600X—15,000X available by replacing the projection lens pole piece.

Electron Optical System: Three-stage electromagnetic. Lens axis factory fixed; objective lens and all apertures easily withdrawn for cleaning without dismantling microscope tube.

**Dual Specimen Holder:** Two specimens can be inserted simultaneously and exchanged by a single operation outside the vacuum.

Electron Diffraction: Triangular variable diffraction aperture is used to obtain diffraction patterns of any desired part of specimen; transmission and reflection diffraction patterns are variable by means of a special specimen holder.

Stereoscopic Micrographs: Three-dimensional presentation of specimens easily obtained.

Photographic Equipment: Six plates (6 x 8 cm or 6.5 x 9 cm) per loading; a 35 mm film magazine containing 36 exposures is provided.

Applications: Biology, medicine, metallurgy, ceramics, cosmetics, paper industry.

## Cincinnati Division

Cincinnati, Ohio



Export Sales: Bendix International Division, 205 E. 42nd St., New York 17, N. Y. Canada: Computing Devices of Canada, Ltd., Box 508, Ottawa 4, Ontario.

PHIPPS & BIRD

VARI-PHASE

VALVE



This valve in conjunction with a source of compressed air is used to control artificial respiration.

Control of one knob facilitates respiration rates of 15 to 50 per minute. The inspiration to expiration time ratio may be set to any value between 1:4 to 4:1. By loosening one screw the valve may be removed for cleaning and sterilizing.

For operation on 115 volt 60 cycle only.

Cat. No. 71-216

## Phipps & Bird, Inc.

MANUFACTURERS AND DISTRIBUTORS OF SCIENTIFIC EQUIPMENT

6th & BYRD STREETS - RICHMOND, VA. 8055 13th STREET, SILVER SPRING, MARYLAND

# Less than 0.007% Ash— for Highest Accuracy



## Ask for S&S "Ash-Free" Analytical Filter Papers

For many years S&S Ash-Free Analytical Filter Papers have been known for their extremely low ash content. They have been the choice of chemists who must have the most precise working tools.

To our knowledge, there is no filter paper with lower ash content on the market. In fact, ash content of S&S Quantitative Papers is considerably lower than all other papers we have tested—less than 0.007%.

Ask your laboratory supply house for S&S Analytical Filter Papers—the finest, most precise filter paper you can specify. Yet S&S quality costs no more. If you would like to receive a free S&S Filter Paper Sampler, made up of many grades, just mail the coupon below.

## MAIL THIS COUPON FOR FREE SAMPLER

	Schleicher & Schuell Co Dept. S-59, Keene, New Hampshire
COC	Gentlemen:
00	Please send me, free, an S&S Analytical Filter Paper Sampler.
Name.	
Compo	any
Addre	18
	State

tributed papers. All those having contributions should communicate with Prof. C. G. Dodd, Chairman, Eighth National Clay Conference, University of Oklahoma, Norman, Okla. A title and a letter of intent should be sent in by 1 June, a 250-word abstract by 1 July.

## Forthcoming Events

June

14-17. American Dairy Science Assoc., Urbana, Ill. (H. F. Judkins, 32 Ridgeway Circle, White Plains, N.Y.)

14-18. American Soc. of Mechanical Engineers, semi-annual, St. Louis, Mo. (O. B. Schier, II, ASME, 29 W. 39 St., New York 18.)

14-19. Society of Automotive Engineers, summer, Atlantic City, N.J. (Meetings Div., SAE, 29 W. 39 St., New York 18.)

15-17. American Neurological Assoc., Atlantic City, N.J. (C. Rupp, 133 S. 36 St., Philadelphia 4, Pa.)

15-17. Some Problems of Normal and Abnormal Differentiation and Development, symp., Bar Harbor, Maine. (N. Kaliss, Roscoe B. Jackson Memorial Lab., Bar Harbor.)

15–17. X-Ray Microscopy and X-Ray Microanalysis, 2nd intern. symp., Stockholm, Sweden. (G. Hoglund, Institutionen for Medicinsk Fysik, Karolinska Institutet, Stockholm 60.)

15-18. American Proctologic Soc., Atlantic City, N.J. (N. D. Nigro, 10 Peterboro St., Detroit 1, Mich.)

15-19. American Meteorological Soc., (with Pacific Div., AAAS), San Diego, Calif. (H. G. Houghton, AMS, Dept. of Meteorology, Massachusetts Inst. of Technology, Cambridge 39, Mass.)

15-19. American Soc. for Engineering Education, Pittsburgh, Pa. (W. L. Collins, Univ. of Illinois, Urbana.)

15-19. Carbon, 4th biennial conf., Buffalo, N.Y. (Carbon Conf., Univ. of Buffalo, Buffalo, 14.)

15-19. Medical Library Assoc., Toronto, Canado. (Miss N. A. Mehne, Upjohn Co., Kalamazoo, Mich.)

15-19. Molecular Structure and Spectroscopy, symp., Columbus, Ohio. (R. A. Oetjen, Dept. of Physics and Astronomy, Ohio State Univ., Columbus 10.)

15-20. Combustion Engines, 5th intern. cong., Wiesbaden, Germany. (Intern. Cong. on Combustion Engines, 6 Grafton St., London, W.1, England.)

15-20. Electric Computers and Information Processing, conf., Paris, France. (Office of Public Information, United Nations, New York, N.Y.)

15-20. Electromagnetic Theory, symp., Toronto, Ont., Canada. (G. Sinclair, Univ. of Toronto, Toronto, Canada.)

15-20. Museums Assoc., 65th annual conf., Worthing, England. (Museums Assoc., 33 Fitzroy St., Fitzroy Sq., London, W.1.)

15-20. Pacific Div.-AAAS, San Diego, Calif. (R. C. Miller, California Acad. of Science, Golden Gate Park, San Francisco 18, Calif.)

15-24. International Commission on Illumination, 14th cong., Brussels, Bel-



gium.

of Stan

Lake S

intern.

Turin.

Culver 16-1

Nuclea

Rome.

Rome.

zionale

Paris.

des Ar

que, P

cists, 2

Van A

of Iow

and H

Conar

34th

Pa.)

18-

neapo

Chem

Pullm 18-

burgh

Lab.,

18-

wank

lumbi

ennia

111

Urba

annu

750 N

Muni

Gesel

gart-

Engin

21

soc., 157 I

21

terial

Pain

phia

ingto

brary

21

inter

Carn

22

22 annu

Scien

22

Cam

15 M

Engi

19-

18-

18-

16-

16-1

16-1

- fiberglas reinforced plastic • one third the weight of stainless steel
  - seamless corners rounded for easy cleaning can be autoclaved repeatedly chemically resistant to acids and staining low thermal conductivity reduces attrition from chilling & upper respiratory diseases variety of sizes & styles at reasonable prices
  - for complete information, write: maryland plastics, inc., federalsburg, md.



. 1380

gium. (L. E. Barbrow, c/o Natl. Bureau of Standards, Washington 25.)

16-18. American Orthopedic Assoc., Lake Placid, N.Y. (L. R. Straub, 715 Lake St., Oak Park, Ill.)

16-18. Circuit and Information Theory, intern. symp., Los Angeles, Calif. (G. L. Turin, Hughes Research Laboratories, Culver City, Calif.)

16-19. Safety and Site Selection for Nuclear Plants, intern. symp., Rome, Italy. (R. Levi, Comitato Nazionale per le Ricerche Nucleari, via Belisario 15,

Rome, Italy.)

16-20. Congress on Nuclear Energy, Rome, Italy. (R. Levi, Comitato Nazionale per le Ricerche Nucleari, via Belisario 15, Rome, Italy.)

16-30. Chemical Arts, intern conf., Paris, France. (Conference Internationale des Arts Chimiques, 28, rue Saint-Domini-

17-20, Colloquium of College Physicists, 21st annual, Iowa City, Iowa. (J. A. Van Allen, Dept. of Physics, State Univ. of Iowa, Iowa City.)

17-21. American Soc. of Ichthyologists and Herpetologists San Diego, Calif. (R. Conant, Philadelphia Zoological Garden, 34th and Girard Ave., Philadelphia 4,

18-19. Colloid Symp., 33rd natl., Minneapolis, Minn. (B. R. Ray, Dept. of Chemistry, Washington State College, Pullman.)

18-19. Ecology of Algae, symp., Pitts-burgh, Pa. (C. A. Tryon, Jr., Pymatuning Lab., Univ. of Pittsburgh, Pittsburgh 13.)

18-20. American Physical Soc., Milwaukee, Wis. (K. K. Darrow, APS, Columbia Univ., New York 27.)

18-20. Animal Reproduction, 4th biennial symp., Urbana, Ill. (P. J. Dziuk, 111 Animal Genetics, Univ. of Illinois, Urbana.)

18-20. Society of Nuclear Medicine, 6th annual, Chicago, Ill. (S. N. Turiel, SNM, 750 N. Michigan Ave., Chicago 11, Ill.)

19-23. Chronometry, intern. cong., Munich, Germany. (Sekretariat, Deutsche Gesellschaft fuer Chronometrie, Stuttgart-N, Koenigstrasse 4, Germany.

21-24. American Soc. of Agricultural Engineers, Chicago, Ill. (J. L. Butt, 420 Main St., St. Joseph, Mich.)

21-26. American Physical Therapy Assoc., Minneapolis, Minn. (Miss J. Bailey, 157 N. 79 St., Milwaukee 13, Wis.)

21-26. American Soc. for Testing Materials, annual, Atlantic City, N.J. (R. J. Painter, ASTM, 1916 Race St., Philadelphia 3, Pa.)

21-27. American Library Assoc., Washington, D.C. (D. H. Clift, American Library Assoc., 50 Huron St., Chicago 11,

21-27. Molecular Quantum Mechanics, intern. conf., Boulder, Colo. (R. G. Parr, Carnegie Inst. of Technology, Pittsburgh,

22-24. American Soc. of Refrigerating Engineers, Lake Placid, N.Y. (R. C. Cross, 234 Fifth Ave., New York 1.)

22-25. Agricultural Inst. of Canada, annual meeting and conv., Winnipeg, Manitoba. (National Research Council, Scientific Liaison Office, Ottawa, Can-

22-25. British Computer Soc., 1st conf., Cambridge, England. (British Computer "A simple method is the practical path to precision"

# This is the most practical pH meter ever made

COMPAX is so simple, so extremely easy to use, that you'll wonder why all pH meters aren't made this way.

The ingenious COMPAX design employs ultra-modern components to save space, maintenance and your operating time. You use one control, read from a dial, work with handy Coleman Electrodes. Precision is 0.02 pH.

Make no mistake . . . this is not a short-cut portable. COMPAX'S high efficiency and low cost (only \$200.00) are the result of modern engineering for mass production.

Skeptical? . . . Try it before you buy it! Clip this coupon to your letterhead and mail to us for a free trial. No strings attached.



Coleman Instruments Inc., Dep Send me a Compax  I would like more is	for a 10-day free	trial.	
Name			
Company			
Address			
City	Zone	State	
			1381



## Nuclear Instruments

AIR MONITORS



Automatically record and warn of  $\alpha$ ,  $\beta$  and  $\gamma$  radiation in airborne particles for periods up to one week, unattended. Fixed or moving filters. Standard and custom units or complete systems.

### PROPORTIONAL COUNTING SYSTEMS



For precision counting of  $\alpha$ ,  $\beta$  and  $\gamma$  radiation from prepared samples. Ideal for C<sup>14</sup>, Ca<sup>45</sup>, P<sup>32</sup> and H<sup>3</sup>. New low power design reduces heat, assures longer life,

#### COUNT RATEMETERS



Operate GM, scintiliation and proportional counting detectors. Equipped to drive recorders and alarms. Logarithmic or linear models for monitoring or laboratory use.

#### PORTABLE SURVEY METERS



High precision, compact, portable Gelger and scintillation counters. Critical components shock mounted and watertight. For precise laboratory measurement or rugged field use.

SEND TODAY FOR FREE LITERATURE

# Nuclear Measurements

Corp. 2460 N. Arlington Ave. Phone: Liberty 6-2415

INDIANAPOLIS 18, INDIANA

International Office: 13 E. 40th St., New York 16, N.Y.

Soc., 29 Bury St., London, S.W.1, England.)

22-25. Waste Disposal in the Marine Environment, 1st intern. conf., Berkeley, Calif. (Dept. of Conferences, University Extension, Univ. of California, Berkeley 4)

22-26. Air Pollution Control Assoc., annual meeting, Los Angeles, Calif. (H. M. Pier, APCA, 4400 Fifth Ave., Pittsburgh 13, Pa.)

22-26. American Inst. of Electrical Engineers, summer general and Pacific meeting, Seattle, Wash. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

22-26. Education in Materials, American Soc. for Engineering Education and American Soc. for Testing Materials, joint symp., Atlantic City, N.J. (R. J. Painter, ASTM, 1916 Race St., Philadelphia 3.)

22-26. International Whaling Commission, 11th meeting, London, England. (IWC, Room 413, 3 Whitehall Place, London, S.W.1.)

23-26. American Home Economic Assoc., Milwaukee, Wis. (Mrs. D. S. Lylc, National Inst. of Drycleaning, Silver Spring, Md.)

23-27. International Dairy Federation, 44th general assembly, London, England. (Secretary General, Intern. Dairy Federation, 202, rue de la Loi, Brussels 4, Belgium.)

24-26. Nuclear Instrumentation, 2nd natl. symp., Idaho Falls, Idaho. (H. S. Kindler, Technical and Educational Services, ISA, 313 Sixth Ave., Pittsburgh 22,

24-26. Significant Trends in Medical Research, Ciba Foundation 10th anniversary symp. (by invitation), London, England. (G. E. W. Wolstenholme, Ciba Foundation, 41 Portland Pl., London, W.1.)

28-4. International Inst. of Welding, annual assembly, Opatija, Yugoslavia. (G. Parsloe, Secretary General, IIW, 54 Princes Gate, London, S.W.7, England.)

29-1. Military Electronics, 3rd natl. conv., Washington, D.C. (L. R. Everingham, Radiation, Inc., Orlando, Fla.)

29-3. Dairy Cong., 15th intern., London, England. (R. E. Hodgson, Animal Husbandry Research Div. Agricultural Research Service, U.S. Dept. of Agriculture, Washington 25.)

29-3. Problems in Pastoral Psychology (Inst. for the Clergy of All Faiths), New York, N.Y. (A. A. Schneiders, Committee for the Inst. for the Clergy, Dept. of Psychology, Fordham Univ., New York 58.)

29-3. Superconductivity, IUPAP colloquium, Cambridge, England. (D. Schoenberg, Dept. of Physics, Univ. of Cambridge, Mond Laboratory, Cambridge.)

29-4. Glass, 5th intern. cong., Munich, Germany. (P. Gilard, International Commission on Glass, 24, rue Dourlet, Charleroi, Belgium.)

30-10. International Electrotechnical Commission, Madrid, Spain. (IEC, 1-3, rue de Varembe, Geneva, Switzerland.)

#### July

1-3. Hydraulics, annual conf., Fort Collins, Colo. (W. H. Wisely, American Soc. of Civil Engineers, 33 W. 39 St., New York 18.)

# 3 ways to get the automatic burette you need

1. Order this one from us. It's identified as item 90850, and accuracy tolerances are as established by the National Bureau of Standards Circular C-434. To make sure you get accuracy between any two points, precision bore tubing is used in the graduated portion. Four sizes — 10, 25, 50, and 100 ml; bottles have capacities of 1000, 1000, 2000, and 4000 ml, respectively.



(clos

Port

ics (

Insti

Sq.,

tion

don,

Ciba

don.

cal

(Dr

aerz

16

Fol

Lor

Lo

anr

All

gar

Ox

Sh

Sc

Pa

tic

Ti

R

6

4

3.

1\_



2. Check pages 199, 200, and 201 in our LG-1 Catalog. This is the section on "Custom" labware. You'll find five other automatic burettes (in addition to the one shown, that is) detailed on these pages. You can get delivery from your regular lab supply dealer. Or you can order direct from us.

3. Send us a sketch. Tell us what you need. Maybe it's a ground joint instead of a stopper, for example. Or, perhaps, instead of a variation you need something completely different. Sketch it. Our skilled lampworkers will do the rest, fashioning what you request from famous Pyrex brand glass that's been the standard for labs for years.



If you don't already have a copy of LG-1 on hand, ask for it. Likewise for the NEW Supplement No. 3. Or send us that sketch. In any case, you'll get what you need, in a hurry.

Special Apparatus Section



## CORNING GLASS WORKS

34 Crystal Street, Corning, New York CORNING MEANS RESEARCH IN GLASS

1-4. British Tuberculosis Assoc., annual (closed), Cambridge, England. (BTA, 59, Portland Pl., London, W.1, England.)

1-5. International Radio and Electronics Conv., Cambridge, England. (British Institution of Radio Engineers, 9, Bedford Sq., London, W.C.1, England.)

2. Radiation and Ageing, Ciba Foundation 3rd annual lecture on ageing, London, England. (G. E. W. Wolstenholme, Ciba Foundation, 41 Portland Pl., London, W.1, England.)

3-5. International Union of the Medical Press, 4th cong., Cologne, Germany. (Dr. Stockhausen, Secretary of Bundesaerztekammer, Cologne.)

4-9. American Soc. of X-ray Technicians, Denver, Colo. (Miss G. J. Eilert, 16 14 St., Fond du Lac, Wis.)

6. Shortening of Lifespan of Mammals Following Irradiation, research forum, London, England. (G. E. W. Wolstenholme, Ciba Foundation, 41 Portland Pl., London, W.1, England.)

6-8. Cell Structure and Function, 10th annual symp., Ann Arbor, Mich. (J. M. Allen, Dept. of Zoology, Univ. of Michigan, Ann Arbor.)

6-8. Oxford Ophthalmological Cong., Oxford, England. (I. Fraser, 21, Degpole, Shrewsbury, Shropshire, England.)

6-8. School and University Health, 3rd intern. cong., Paris, France. (Comité d'Organisation du Congres d'Hygiene Scolaire et Universitaire, 13, rue du Four,

111

d-

n e

ou

m

an 18.

inv

S

ork

SS

129

6-11. Seed Testing, intern. conv., Oslo, Norway. (Intern. Seed Testing Association, Danish State Seed Testing Station, Thorvaldsensvej, 57, Copenhagen V, Den-

6-12. Chagas' Disease, intern. cong., Rio de Janeiro, Brazil. (C. Chagas, Instituto de Biofisica, avenida Pasteur 458, Rio de Janeiro.)

7-10. Royal Medico-Psychological Assoc., annual meeting, Glasgow, Scotland. (RM-PA, 11, Chandos Street, London, W.1, England.)

12-17. American Waterworks Assoc., annual conv., San Francisco, Calif. (H. E. Jordan, AWA, 521 Fifth Ave., New York 17.)

13-17. National Assoc. of Power Engineers, natl. conv., Boston, Mass. (A. F. Thompson, Secretary, NAPE, 176 W.

Adams St., Chicago, Ill.)

13-17. Plastic Surgery, 26th intern.
cong., London, England. (D. Matthews, Organizing Secretary, Intern. Cong. on Plastic Surgery, c/o Inst. of Child Health, Hospital for Sick Children, Great Ormond St., London, W.1.)

13-17. Standardization, intern. (council meeting), Geneva, Switzerland. (ISO, 1-3, rue Varembe, Geneva.)

15. American Soc. of Facial Plastic Surgery, New York, N.Y. (S. M. Bloom, 123 E. 83 St., New York 28.)

15-17. Fluorine Chemistry, symp., Birmingham, England. (Chemical Soc. of London, Burlington House, Piccadilly, London, W.1.)

15-17. Shaft Sinking and Tunnelling, symp., Olympia, London, England. (Institution of Mining Engineers, 3, Grosvenor Crescent, London, S.W.1.)

15-18. British Assoc. of Urological Sur-

# DURALAB

## LABORATORY FURNITURE AND EQUIPMENT

MANUFACTURERS & DESIGNERS OF

- A Complete Line of Superior Quality
- . TABLES . CABINETS
- e CASES e FUME HOODS
- a PADIO CHEM LAB FOUIP.

See our catalog in Sweets Architectural File 23L Du

e For Catalog D2 Illustrating our complete line of Labora-tory Furniture and Equipment, write today





FUME HOOD model DAIRCOL (illustrated) has been devel-aped for the Air Conditioned Laboratory. Write for full Specifications.

copy of our complete Hood Catalog DH3 is on request. Write today.



DURALAB EQUIPMENT CORP., 980 LINWOOD SIKEET BROOKLYN 8, N. Y.

980 LINWOOD STREET





The NEW Schwarz Price List contains over 200 Schwarz manufactured biochemicals and radiochemicals. In addition to the NEW COMPOUNDS available for the first time, NEW LOW PRICES are listed for many of the other Schwarz Quality Compounds. Rigid controls and assays guarantee that each Schwarz Compound meets the high specifications required for laboratory and manufecturing use.



LABORATORIES, INC. 230B Washington Street Mount Vernon, New York

Please send your New		
Name	TI	tie
Company		
Address		

geons (members and guests), Glasgow, Scotland. (Joint Secretariat, 45, Lincoln's Inn Fields, London, W.C.2, England.)

15-18. British Cong. of Obstetrics and Gynaecology, 15th, Cardiff, Wales. (BCOG, Maternity Hospital, Glossop Terrace, Cardiff.)

15-24. British Medical Assoc., Edinburgh, Scotland. (BMA, Tavistock, Sq.,

London, W.C.1, England.)

16-24. Canadian Medical Assoc., 92nd annual meeting in conjunction with the British Medical Assoc., Edinburgh, Scotland. (A. D. Kelly, CMA, 150 St. George St., Toronto 5, Ontario, Canada.)

17. High Energy Nuclear Physics, 9th annual intern. conf. (Intern. Union of Pure and Applied Physics, Moscow, U.S.S.R.). (R. E. Marshak, Univ. of Rochester, Rochester, N.Y.)

19-24. American Crystallographic Assoc., Ithaca, N.Y. (J. Waser, Rice Inst., Houston 5, Tex.)

19-25. Pediatrics, 9th intern. cong., Montreal, Canada. (R. L. Denton, P.O. Box 215, Westmount, Montreal 6.)

20-26. Radiation and Atmospheric Ozone, joint symp., by Intern. Union of Geodesy and Geophysics and World Meteorological Organization, Oxford, England. (WMO, Campagne Rigot, 1, avenue de la Paix, Geneva, Switzerland.)

22-23. Rocky Mountain Cancer Conf., Denver, Colo. (N. Paul Isbell, 835 Re-

public Bldg., Denver 2.)

23-30. Radiology, 9th intern. cong., Munich, Germany. (Sekretariat des 9 Internationalen Kongresses für Radiologie, Reitmorstrasse 29, Munich 22.)

26-30. International Psychoanalytical

Assoc., Copenhagen, Denmark. (Miss P. King, 37 Albion St., London, W.2, England.)

27-4. International Federation of Translators, Bad Godesberg, Germany, (Dritter Internationaler FIT-Kongress, Kongress Sekretariat, Bundesverband der Dolmetscher und Übersetzer e. V. (BDÜ) Hausdorfstrasse 2, Bonn, Germany.)

30-31. Computers and Data Processing, 6th annual symp., Estes Park, Colo. (W. H. Eichelberger, Denver Research Inst., Univ. of Denver, Denver 10, Colo.)

#### August

1-8. World Congress of Esperantists, 44th, Warsaw, Poland. (Office of Intern. Conferences, Dept. of State, Washington

4-5. American Astronautical Soc., 2nd annual western, Los Angeles, Calif. (A. P. Mayernik, AAS, 6708 53 Rd., Maspeth

78. N.Y.

6-8. Human Pituitary Hormones, colloquium (by invitation only), Buenos Aires, Argentina, (G. E. W. Wolsten-Aires, Argentina. (G. E. W. holme, Ciba Foundation, 41 Portland Place, London W.2, England.)

9-12. American Soc. of Mechanical Engineers (Heat Transfer Div.), conf., Storrs, Conn. (D. B. MacDougall, ASME, 29 West 39 St., New York 18.)

9-15. Physiological Sciences, 21st intern. cong., Buenos Aires, Argentina. (C. F. Schmidt, Univ. of Pennsylvania School of Medicine, Philadelphia 4.)

10-13. National Medical Assoc., Detroit, Mich. (J. T. Givens, 1108 Church St., Norfolk, Va.)

10-13. Society of Automotive Engineers, natl. West Coast meeting, Vancouver, B.C., Canada. (R. W. Crory, Meetings Operation Dept., SAE, 485 Lexington Ave., New York 17.

16-19. Botanical Nomenclature, discussions (Intern. Bureau for Plant Taxonomy and Nomenclature), Montreal, Canada, (J. Rousseau, Natl. Museum, Ottawa, Canada.)

16-21. American Pharmaceutical Assoc., Cincinnati, Ohio. (R. P. Fischelis, APA, 2215 Constitution Ave., NW, Washington 7.)

17. Ultrasonics, natl. symp., San Francisco, Calif. (L. G. Cumming, Inst. of Radio Engineers, 1 E. 79 St., New York 21.)

17-21. Pacific Southwest Assoc. of Chemistry Teachers, Pacific Grove, Calif. (W. A. Craig, 416 N. Citrus Ave., Los Angeles 36, Calif.)

17-22. Logopedics and Phoniatrics, 11th intern. cong., London, England. (Miss P. Carter, 46 Canonbury Square, London N.1, England.)

19-26. Refrigeration, 10th intern. cong., Copenhagen, Denmark. (M. Kondrup, Danish Natl. Committee, Intern. Congress of Refrigeration, P.O. Box 57, Roskilde, Denmark.)

19-29. Botanical Cong., 9th intern., Montreal, Canada. (C. Frankton, Secretary-General, 9th Intern. Botanical Cong., Science Service Bldg., Ottawa, Ontario,

19-29. International Assoc. of Wood Anatomists, Montreal, Canada. (IAWA, Laboratorium für Holzforschung E.T.H. Universitatstrasse 2, Zurich, Switzerland.)

## *Villipore* brief #155

Identification of Micron and Submicron Particles.

Techniques are described for identification and size estimation of water or acid-soluble atmospheric particles. After collection, MF filter is placed on appropriate reagent solution (from 3 to 20 minutes). Filters are then washed, dried, mounted and microscopically examined (dark field) for characteristic reaction "spots." Reagents and spot characteristics are given.

Lodge, J. P., Jr., Tufts, B. J. Tellus VII, 1956, 2

## *lillipore* BRIEF #201

Methods for the Evaluation of Pasteurization.

Two methods, one enzymatic and one microbiological, are described to test beer for adequacy of the pasteurization received. The second method uses an HA Millipore filter to retain all organisms from a beer sample. Yeast colonies will develop on the MF in 36 to 48 hours on hopped wort at 23°C. Lactobacilli and pediococci develop on the MF in 6 to 14 days on hopped wort agar in CO2 atmosphere at 23°C.

Haas, G. J., Fleischman, A. I. Wallerstein Laboratory Communications XX:68, March, 1957

## *lillipore* brief #166

Use of Membrane Filters in the Measurement of Biological Incorporation of Radioactive Isotopes.

A technique is presented for accurately estimating by direct radiation counting the total isotope incorporation into metabolizing cells. After exposure to the labeled substrate (C<sup>14</sup>O<sub>2</sub>) the cells are killed, transferred to 10-20 ml. H<sub>2</sub>O, and filtered through a 1" HA Millipore filter. After flushing and drying, the MF is introduced into a gas-flow chamber for direct counting of B radiation from the dry cells.

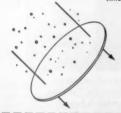
Atkinson, D. E., McFadden, B. A. Journal Bacteriology, 71:1:123-24, 1956

## *lillipore* BRIEF #217

Critical Comparison of Collection Efficiencies of Commonly Used Aerosol Sampling Devices.

The extent to which the theory of collection techniques could be applied to commonly-used field instruments has been determined. Instruments included sedimentation chambers, MSA electric precipitator, Greenberg-Smith impinger, Millipore Filters, Cassella thermal precipitator and an im-Collection efficiencies for MF's were greater than 99% for all aerosols. Glycerol aerosols were collected at greater than 99.995% with the MF — the limit of measurement.

Schadt, C., Cadle, R. D. Analytical Chemistry, 29:6:864-68, June, 1957



Attach This to Your Letterhead Send catalog, price list and tech-

fields of interest are:....

sign your name and mail to

Millipore FILTER CORPORATION Dept. S, Bedford, Massachusetts

## ABSOLUTE SURFACE RETENTION OF **ALL PARTICLES LARGER THAN PORE SIZE**

Particles screened from liquids or gases lie directly on the surface of the Millipore filter in a single plane — where they may be readily examined or tested. Fluids cleaned with 100% cut-off at specific pore size.

- 50 million capillary pores of precise size per sq. cm. of surface area.
- Absolute surface retention of all particles larger than pore size.
- nical bibliography. My principal | Pores are 80% of total filter volume, permitting high flow rates.
  - Heat and chemical resistance characteristics typical of esters of cellulose.
  - Filter becomes completely transparent for microscopy by applying immersion oil.

• Ten porosity grades from 0.01 μ to 5.0 μ.



## RELIABILITY is a must when tissue culture research demands special serums

Tissue culture laboratories throughout the nation find the imperative ingredient... reliability ... at Colorado Serum Co.

Thirty-five years of serum production experience and constant research are embodied in every product. To insure the highest quality in a wide selection of animal bloods and serums, Colorado Serum Co. maintains a variety of fine animals.

Order with confidence from Colorado Serum Co.

NOW AVAILABLE BOVINE FOETAL SERUM

WRITE FOR FREE CATALOG TODAY No salesman

will call

COLORADO

Inharatory and Ganaral Office

4950 York Street - Denver 16, Colorado - MAin 3-5373

-RESPONSE RECORDER for densitometry in paper electrophores

Recording function electrically = adjustable from linear to ±



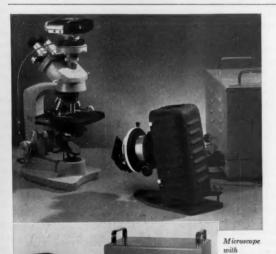
ed specifically to be used with scanning densitometers for correctly-

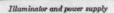
Write for Bulletin #1100

10 to 200 millivolts

HOTOVOL

95 Madison Ave.





## Newest Equipment for

## **Fluorescent Microscopy**

The rapid, microscopic technic for identifying microorganisms and antigens in tissue.

Aloe Scientific now offers as a complete package the latest equipment and reagents necessary for fluorescent microscopy. These basic assemblies permit the most versatile application possible.

With the new procedure, specific antibodies formed in the tissues can be tagged or labeled with fluorescent dye so they will glow under ultraviolet light. This technic has aided in much faster identification of pathogenic and nonpathogenic microorganisms, and greatly speeded up diagnosis of a wide range of diseases.

Modifications of the AO Phasestar microscope make it ideal for fluorescent study, in addition to phase, bright field and photomicrography. If desired, your present microscopic equipment may be converted for fluorescence by interchanging and adapting objectives and accessories suggested.

To determine the exact equipment you need, write today for descriptive bulletin FM-459 and complete bibliography on fluorescent microscopy.

aloe scientific DIVISION OF A. S. ALOE COMPANY

5655 Kingsbury . St. Louis 12, Missouri

FULLY STOCKED DIVISIONS COAST-TO-COAST



OUR 100TH YEAR

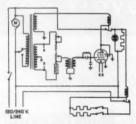
## **Total Re-Design for Freas Laboratory Ovens**

Freas laboratory ovens have recently undergone a complete design change and now offer such innovations as an electronic control system, higher operating temperatures and advanced styling features which combine to provide greater operating dependability and



## **New Control Dependability**

The most interesting feature of the new oven line is the electronic control system which utilizes a resistance thermostat acting through an electronic tube and sealed mercury relays. Moving parts-usually the cause of oven control failures in hydraulic thermostat systemsare completely eliminated. The simple circuitry of the new system is shown below.



## **Higher Operating Temperatures**

Increased insulation, internal reinforcing and generally improved construction coupled with the electronic control now allow operating temperatures up to 325°C setting a new high in the laboratory oven field.

## **New Operating Convenience**

The functionally grouped controls offer new ease of operation. The control dial is calibrated for direct temperature selection. The modern exteriors are easy to clean and maintain. Work load capacity and temperature uniformity in gravity convection models has been greatly increased by a unique airflow system.

Whether your needs are for standard ovens, vacuum, incubators, sterilizers, low temperatures, high temperatures (1000°F.) or special purpose models, you will find them all fully described in Bulletin #302-contact your Distributor or PRECISION.

Since 1920

The Finest in Quality Laboratory Apparatus



3735 WEST CORTLAND STREET CHICAGO 47, ILLINOIS

## New Products

The information reported here is obtained from manufacturers and from other sources considered to be reliable, and it reflects the claims of the manufacturer or other source. Neither Science nor the writer assumes responsibility for the accu-racy of the information. A coupon for use in making inquiries concerning the items listed is in-cluded in the postcard insert.

- MICROTITRATOR permits titration of quantities as small as a single drop; endpoint is detected electrometrically. The apparatus is equipped with microelectrodes for oxidation-reduction and for acidimetry-alkalimetry titrations. The apparatus requires a high-impedance, stable-zero pH meter. (Manostat Corp., Dept. 793)
- OHMMETER measures resistance to 5000 megohms. The portable instrument has its own transistorized power supply for test potentials to 1000 v d-c. Mercury cells provide voltage stability. Accuracy of ± 3.0 percent is claimed for the upper half of the scale. The instrument cannot be damaged by short circuits. (Mideastern Electronics, Inc., Dept. 799)
- VACUUM GAGE combines an ionization gage tube of the cold-cathode type, a magnet, and a power supply. Ion current is amplified and indicated on a panel meter. Full-scale pressure ranges are 10-8 to 10-7 mm-Hg. Calibration is linear from 10-4 to 10-8 mm-Hg. (Miller Laboratories, Dept. 807)
- LIQUID-LEVEL GAGE employs a capacitive detector to measure continuously the level of liquids or granular solids. Height of the material produces a capacitance change that is measured by a self-balancing bridge with read-out in dial, counter, or other form. Accuracy of ± 0.1 in. over a 10-ft range is claimed. (Magnetic Instruments Co., Dept. 809)
- SHUTTER CALIBRATOR is designed to check shutter operation of radar recording cameras. The period during which the shutter is open or closed can be read within ± 0.001 sec directly from film exposure. The calibrator provides a light spot rotating 5 times per second behind a transparent scale. Shutter open time is read from the scale readings at the ends of the trace made by the rotating spot. (Mast Development Co., Dept. 811)
- MICROSCOPE ACCESSORIES include a trinocular block, a chronophotometer, and a microscope illuminator. The trinocular block, for attachment to standard research-type microscopes, makes possible simultaneous photomicrography, visual observation, and projection. The block contains either monocular or binocular eyepieces; plate or film cameras can be mounted on it. The projection lens can be used to carry the image to an acces-

## DalaC LABORATORIES

Over 250 New Reagents for Medical Research and Biochemical Testing

sory o

lu, th expos

nator

filam

aplan

matic

Corp.

SIGN

brate

and :

0.01

100 µ

cent.

at 40

cent.

(Ken

DUA

tical

deper

on su

at a

ity i

sweep

(Hev

- ANA

meas

range

Weig

is gi

mani

meth

to 20

the c

conta

weigl

Accu

(E-H

tache

mete

in eig

10,00

may

db be

of th

appr

tories

TRA

volta

nal 2

30 a

drop

put s

mum

Co.,

Carbobenzoxy chloride Peptide synthesis Naphthol AS acetate Esterase

2-Hydroxy-3-Naphthoic acid hydrazide Ketosteroids and carbonyl group

Fluorescein isothiocyanate Fluorescence microscopy Carbonaphthoxy choline iodide Choline esterase

LNA® LNA®
Leucyl amino peptidase substrate
Mercury Orange [1,4-Chloromercuriphenylazo]-naphthol-2
Sulfhydryl groups

HABA [2,4-Hydroxyazobenzene benzoic

Albumin and protein binding Lauroyl choline chloride Choline esterase beta-Naphthyl caprylate Lipase substrate

Neutral buffer formalin

INT 2-[p-lodophenyl]-3-p-nitrophenyl-5-phenyl tetraxolium chloride Succinic dehydrogenase

Giemsa stain; Wright stain In response to many requests, these and other high quality stains are now being prepared in our laboratories.

Write for catalog today. Custom Syntheses Invited

> THE Borden CHEMICAL COMPANY SOOD LANGDON STREET . P. C. BOX 952 PHILADELPHIA 24, PA.

The American Association for the Advancement of Science announces three new symposium volumes of the utmost importance to psychiatrists, neurologists, clinical psychologists, physiologists, pharmacologists, and biochemists-and of great interest to the general public.

## **Tranquilizing Drugs**

6" x 9", 205 pp., 32 illus., references, index, cloth, March 1957. Price \$5.00. AAAS Members' cash order price \$4.50.

### **Psychopharmacology**

6" x 9", 175 pp., bibliographies, index, cloth, 1956. Price \$3.50. AAAS Members' cash order price

## Alcoholism-**Basic Aspects and Treatment**

6" x 9", 220 pp., 33 illus., references, index, cloth, May 1957. Price \$5.75. AAAS Members' cash order price \$5.00.

## **AAAS Publications**

1515 Mass. Ave., NW, Washington 5, D.C.

TH: repea a cir

> of a trica a pai

> > 15 M

reacl

sory chronophotometer, sensitive to 10-6 lu, that provides push-button control of exposure from 0.7 to 60 sec. The illuminator is a xenon-atmosphere, tungstenflament unit with either a two-lens aplanatic condenser or a five-lens achromatic condenser. (Canal Industrial Corp., Dept. 802)

- SIGNAL GENERATOR produces long, calibrated pulses as well as sine, triangular, and square waves. Frequency range is 0.01 to 2000 cy/sec. Pulse lengths are 100 µsec to 10 sec with accuracy ±3 percent. Maximum pulse amplitude is 50 v at 40 ma. Frequency stability is ±1 percent, amplitude stability ±2 percent. (Kennedy Company, Dept. 812)
- ■DUAL-TRACE OSCILLOSCOPE has twin vertical amplifiers that may be operated independently, differentially, or alternately on successive sweeps, or may be chopped at a 40-kcy/sec rate. Maximum sensitivity is 10 mv/cm. Fifteen calibrated sweeps range from 5 µsec to 200 msec/cm. Frequency range is to 200 kcy/sec. (Hewlett-Packard Co., Dept. 813)
- ANALYTICAL BALANCE features 1-sec measurement time in five automatic ranges from 30 to 3000 mg full scale. Weight of samples placed on the balance is given directly with no mechanical manipulation. Conventional difference methods may be used to extend the range to 200 g. An electrical mass offset allows the operator to zero the meter with a container on the balance, thus permitting weight of contents to be read directly. Accuracy of ±0.2 percent is claimed. (E-H Research Laboratories, Dept. 814)
- Toctave BAND FILTER SET, when attached to the manufacturer's sound-level meter, permits measurements to be made in eight octave bands ranging from 20 to 10,000 cy/sec. Noise in octave bands may be measured at levels more than 36 db below the over-all noise level. Weight of the combination filter and meter is approximately 19 lb. (Allison Laboratories, Dept. 815)
- ■TRANSIENT PROTECTOR reduces highvoltage transients appearing at a nominal 28-v power line. Load currents up to 30 amp may be passed with a voltage drop of 1. The clipping level of the input spike voltage, which may be a maximum of 80 v, is 35 v. (Alto Scientific Co., Dept. 816)
- THERMAL SWITCH is a miniature, nonrepeating device which operates to close a circuit when specific temperature is reached. The device operates by fusion of a thin layer of material of high electrical resistance. Liquifaction of the insulating barrier permits a spring to close a pair of contacts. Latching action main-

## RADIOACTIVITY AT WORK ... \*2

Our business is radioactivity—applying it, measuring it, protecting against it

This is the second in a series of reports devoted to NSEC's work with the exciting new tool, radioactivity. Its uses appear endless, not only in the nuclear industry, but also in the fields of chemicals, petroleum, pharmaceuticals, medicine, steel and coal. Applied radioactivity helps us examine product and process improvements, indicates ways to reduce costs, and probes for answers to complex research problems. With radioisotopes and radioactivity, we seek solutions by methods never before practical or economically feasible.

One of our project descriptions may apply directly to a problem you are facing, or point up a general application in your field. Take advantage of NSEC's specialized skills and equipment. See how safely and profitably the phenomena of radioactivity can be put to work for you.

## **ACTIVATION ANALYSIS**

Where a high degree of quality control is desired, activation analysis offers a sensitivity far exceeding conventional quantitative analysis. Elements in quantities as minute as one part per billion can be identified and measured. Activation analysis is important in manufacturing, and in research projects requiring rigid standards of purity. It is especially useful in the processing of rare or expensive materials since, in most cases, only a fraction of a gram of material is required.

In activation analysis, exposure of the test sample to a stream of neutrons creates radioisotopes with distinct radiation characteristics. Even minute quantities of trace elements are made sufficiently radioactive that sensitive counting equipment can measure them. Activation analysis may be performed for as many trace elements as desired in a single small sample.

NSEC offers activation analysis as a commercial service. We can handle complete testing and analysis or can assist in establishing a standardized procedure for production line use. Ask Dr. Paul Kruger, Manager of our Chemistry Department, about this service.

#### RADIOTRACERS IN BIOMEDICAL RESEARCH

Radiotracing is proving extremely valuable in medical and pharmacological research. Radioactive tracers in infinitesimal amounts are used to follow the course of a substance through a living organism. With tracers, research scientists discover where the substance goes, how long it takes to get there, and what happens when it arrives.

Recently, NSEC completed a study determining the behavior of a radioactive enzyme for a drug manufacturer. Information was needed regarding the speed with which the product was absorbed and how it was distributed in the body. The experiments provided valuable data for the manufacturer. Extended animal tracer experiments are now

in progress and human studies are about to be undertaken.

Information about the method and radioisotope selected will soon appear in a scientific journal. For additional information on this and similar tracer studies, just write us. Our report on services for study of the reticuloendothelial system is also available.

#### PROJECT SUNSHINE

When an atomic bomb test is made anywhere on earth, radioactivity is scattered into the air and carried about by wind currents. These "hot" atoms fall with precipitation and settle on animals, vegetation, soil, and water. This fallout contains the dangerous radioactive nuclide, strontium-90, and it is desirable to maintain constant knowledge of the amount.

To monitor this fission fallout, the Atomic Energy Commission set up "Project Sunshine." NSEC has been active in the program since 1955, analyzing samples received from all over the world. NSEC recently has been awarded two additional major contracts to measure fallout in Pittsburgh rainfall and in particulate material in the air.

Close to half the fallout measurements, and most of the particulate material analyses in this country are being conducted by NSEC.

NSEC is one of very few private firms with the necessary low-level counting equipment to perform such vital work. This, and similar apparatus designed and built by our staff, is used to conduct research that leads to a better life for us all. Would you like to discuss the ways it might assist you?

### FISSION PRODUCT BEHAVIOR IN A REACTOR SLURRY

In a proposed nuclear power reactor, the fuel used is a slurry of uranium oxide and thorium oxide particles. NSEC made a preliminary study of the probable distribution of fission products within the reactor, to aid in the design of the fuel-decontamination processes. High pressure, high temperature studies were made in an autoclave using reactor-irradiated slurries, as well as synthetic mixtures of fission products.

NSEC has conducted hundreds of radiochemical analyses of experimental nuclear fuel elements, reactor coolant water and other reactor components. NSEC also assists in determining fuel burn-up efficiency, and the rate of gain for breeder reactors. We are taking part in the development of nuclear power plants for aircraft, and are advising many firms which are fabricating fuel elements for various reactors.

If your work involves nuclear reactors or components, call us at HOmestead 2-4000 in Pittsburgh. We'll work with you from the preliminary environmental radioactivity survey through the disposal or use of the radioactive waste.

For more detailed information on our studies and services, just call or write. Proposals and quotations on your specific needs will be made without cost or obligation. And if you would like to keep informed of the latest developments in this constantly changing field, just write on your letterhead and ask us to put you on the mailing list for our monthly publication, "Radioactivity at Work."

Our expanding business requires additional qualified technical personnel. Interested? Submit resume to Personnel Manager.

Nuclear Science and Engineering Corporation DEPT. S-6, P. O. BOX 10901, PITTSBURGH 36, PENNSYLVANIA

tains a closed circuit regardless of subsequent temperature changes. Accuracy is ±2 percent. Switching temperatures from 150° to 500°F are available. Resistance immediately below switching temperature is 100,000 ohm. Current capacity is more than 5 amp at 220 v. (Minitec, Dept. 804)

POWER SUPPLY furnishes 10 amp at 24 to 32 v. Regulation is ±0.1 percent for line changes and ± 0.4 v for load changes. Output impedance is 0.05 ohm; ripple is 2 mv r.m.s. (Perkin Engineering Corp., Dept. 819)

COUNTER-SCANNER records information from one to six electronic counters on a single digital recorder. The scanner operates from staircase voltages produced by the counters. Readings from the scanned counters are recorded sequentially on adding-machine tape, with an identifying digit for each data source. Preset decimal information manually selected by six decimal dials on the scanner may also be automatically recorded. The instrument synchronizes the count and display functions of the counters and the printing function of the recorder. (Dymec Inc., Dept. 833)

CONTOUR PHOTOCELLS are selenium photovoltaic cells that can be produced in curved, cylindrical, or other configuration, or in three-dimensional shapes with radius of curvature as little as 1 in. Cell sizes range from 1/4 by 1/4 to 10 by 10 in. (International Rectifier Corp., Dept.

DIAMOND KNIFE AND HOLDER ASSEMBLY for ultra microtomy permits sectioning of hard material. The knife may be moved laterally, and the knife and holder may be removed and replaced in the microtome without reorientation. thus permitting a dulled portion to be replaced with a sharp portion without resharpening. (Ivan Sorvall, Inc., Dept. 829)

■ MICROWAVE EQUIPMENT available for frequencies up to 140 kMcy/sec includes crystal multipliers, crystal mounts, E-H tuners, cavity wavemeters, standing-wave detectors, phase shifters, attenuators, elbows, twists, terminations, standard-gain horns, movable shorts, and magic T's. (De Mornay-Bonardi, Dept. 817)

LINEAR ACCELERATOR generates 6 Mv for medical therapy and research applications. Electron beams up to 500 w at energies from 2 to 7.5 Mev are produced. X-ray output is 200 r/min at 100 cm. Electron-beam diameter is less than 5 mm at the x-ray target. (High Voltage Engineering Corp., Dept. 818)

SHAFT-ANGLE ENCODER provides up to 1024 code positions per rotation. The device is a sealed unit designed to operate at temperatures from -65° to +162°F and at vibrations to 1 kcy/sec. Precious--metal-alloy brushes are used. (Datex Corporation, Dept. 822)

■ ULTRAVIOLET MICROSCOPE uses an ultraviolet image-converter tube, called the Ultrascope, to permit visual focusing. The image converter unit, combining the Ultrascope tube and a 35-mm camera, is available separately for use on existing monocular microscopes. A grating monochromator to serve as an ultraviolet source is offered as an accessory. (Bausch & Lomb Optical Co., Dept. 823)

WATER MONITOR for fission products provides warning of fuel-element leakage or rupture. The instrument uses ionexchange resin columns to separate iodine fission products from the main coolant stream. Each iodine isotope is discriminated individually so that only those related to fuel-element leakage are detected. The instrument is available for pressures exceeding 2500 lb/in2. Sensitivity is 11,000 count/min µc of I135 with a background of 125 count/min. (Tracerlab-Keleket, Dept. 831)

Record directly

potential current resistance temperature polarograms and more



## FISHER RECORDALL

the universal laboratory recorder



The all-purpose Fisher Recordall gives you the advantages of continuously recorded data and permanent records without the expense of specialized, limited-use recording instruments. Any laboratory instrument whose reading can be converted into a DC signal can be recorded by the Recordall. Even such rapidly changing variables as polarographic current are charted with precision.

11 current and potential ranges, direct reading scales, wide variety of adapters and accessories . . . these are only a few of the features that make the Fisher Recordall one of the laboratory's most flexible and useful

## SEND FOR THE FULL DETAILS ...

in the 12-page Fisher Recordall

139 Fisher Building . Pittsburgh 19, Pa.



## ISHER SCIENTIFIC

erica's Largest Manufacturer-Distributor of Laboratory Appliances & Reagent Chemicals IN THE U.S.A. Cleveland St. Louis IN CANADA

Boston Charleston, W.Va. Chicago

Detroit New York Philadelphia Pittsburgh

Washington Edmonton

Montreal IN MEXICO Mexico City Toronto

B-76b

SCIENCE, VOL. 129

1388

are in phase record may Sarge silicat

lubric

fused

VIBRA'

detects

and me

Input ra

mv. Ac

on the

the 10-

output

stable

period.

ohm.

BELEC'

three-c

experi

system

first is

and co

amplif amplif

sis, is

installa

DATA

tape p

machi

per see

tric or 5-, 6-

(Victo

832)

RECO

design

opera

824)

rel. I and f iustal Dept DIGI

motio bit n for c recor velor rator form

ment film. spaci Lam oper

seco

infor

(Tra Was

15 M

SVIBRATING CONDENSER ELECTROMETER detects currents as small as 10-15 amp and measures resistances to 1015 ohm. Input ranges are 10, 30, 100, 300 and 1000 mv. Accuracy varying from ± 0.3 percent on the 1000-my range to ±2 percent on the 10-mv range is claimed. Full-scale output is 1 ma d-c on all ranges. Zero is stable within ± 100 µv over a 12-hr period. Input resistance is 1014 or 1016 ohm. (Herman H. Sticht Co., Dept.

ium

1Ced

ura-

Cell

0 in.

ept.

IBLY

ning

v be and

aced

tion,

o be

hout

Dept.

for

ludes

E-H

wave

s, el-

-gain

T's.

Mv

appliw at

uced.

cm.

an 5

ltage

up to ne de-

perate

62°F

cious-

Datex

ultra-

d the

using. ng the

era, is

risting

mono-

violet Bausch

oducts

leak-

es ion-

iodine

coolant scrimi-

ose re-

re de-

ole for

Sensi-

of I135

t/min.

OL. 129

■ ELECTROCARDIOGRAPH SYSTEM is a three-channel instrument designed for experiments at high acceleration. The system is contained in two sections. The first is designed for stresses up to 200 g and consists of three single-channel preamplifiers. The second section, including amplifiers, power supply, and input chassis, is designed for standard rack-panel installation. (Epsco Corp., Dept. 826)

DATA-PROCESSING DEVICE combines a tape punch with a full-keyboard adding machine. The punch operates at 20 digits per second. Keyboard input may be electric or manual. The punch will produce 5-, 6-, 7- or 8-channel punched tape. (Victor Adding Machine Co., Dept.

RECORDING POLAROGRAPH is said to be designed for maximum simplicity of operation in routine analysis. Facilities are included for application to every phase of conventional polarography. The recording potentiometer of 2.5-mv range may be applied to other uses. (E. H. Sargent and Co., Dept. 825)

■ STOPCOCK with Teflon plug and borosilicate-glass barrel is said to require no lubrication because it has a permanently fused inner-surface treatment of the barrel. Large taper angle prevents binding and freezing, and the plug tension is adjustable. (Scientific Glass Apparatus Co., Dept. 827)

DIGITAL RECORDING DEVICE for 35-mm motion picture cameras provides a 96bit matrix image on each frame of film for correlating coded data with pictorial records in real time. The recorder, developed by Magnavox Research Laboratories, uses two 48-lamp assemblies to form a 96-lamp array. A prism arrangement projects the matrix image onto the film. Each lamp image measures 10 mils on a side and is separated by 10-mil spacing from adjacent lamp images. Lamps operate on 1 v. Cameras can be operated at speeds up to 80 frames per second; at this rate 7680 bits of coded information are recorded each second. (Traid Corporation, Dept. 834)

JOSHUA STERN National Bureau of Standards, Washington, D.C.

PERSONNEL PLACEMENT

CLASSIFIED: Positions Wanted, 25¢ per word, minimum charge \$4. Use of box number counts as 10 additional words. Payment in advance is required. Positions Open, \$33 per inch or fraction thereof. No charge for box number.

number.

COPY for classified ads must reach SCIENCE 2 weeks before date of issue (Friday of every week).

DISPLAY: Rates listed below—no charge for box number. Monthly invoices will be sent on a charge account basis—provided that satisfactory credit is established.

established.

Single insertion \$33.00 per inch
4 times in 1 year 30.00 per inch
7 times in 1 year 25.00 per inch
13 times in 1 year 27.00 per inch
52 times in 1 year 25.00 per inch
For PROOFs on display ads, copy must
reach SCIENCE 4 weeks before date
of issue (Friday of every week).

Replies to blind ads should be addressed plies to bling atta anomalisms follows:

Box (give number)
Science
1515 Massachusetts Ave., NW
Washington 5, D.C.

## POSITIONS WANTED

Advertising Manager, 13 years' experience scientific and optical instruments (work has won awards), desires post with growing company or technical group with publication. Résumé available. Box 109, SCIENCE.

Biologist, Ph.D., wants position in junior college, teachers' college, or liberal arts college. Box 110, SCIENCE.

Expert Medical Writing (clinical research, monographs, books, brochures); also medical contrary research and abstracting. Box 120, SCIENCE

Mathematician, M.A. (chemistry), anxious to start over in mathematics; 31 semester hours mathematics, 13 hours A's. 138 Broad Street, Charleston, S.C.

## POSITIONS OPEN

## ADMINISTRATIVE ASSISTANT RESEARCH

A leading pharmaceutical firm requires an administrative man for research di-vision. Job includes line and staff functions. Experience in research, industrial relations, budget, supplies, and services helpful. Job reports to manager of re-search administration. Must have at least a B.S. degree in physical or bio-logical sciences. Send complete résumé, including salary requirements to

Box 108, SCIENCE

ANIMAL ECOLOGIST II

Vacancy on the island of Hawaii with the plague research program of Hawaii Department of Health. Requires 7 years of professional research experience in zoology, mammalogy, animal ecology, or entomology of which 2 years shall have involved planning and conducting research projects, and graduation from a college or university of recognized standing with a master's degree in zoology, mammalogy, entomology, or a related biological science; or any equivalent combination of experience and training. Salary, \$666 per month. Continuous recruitment until need is met. Write to Mrs. Loretta Fukuda, Recruiting and Examing Supervisor, Department of Civil Service, Territory of Hawaii, 252 Millaini Street, Honolul 13, Hawaii, for additional information and application.

Endocrine Technician, B.S. in chemistry. Experience in endocrine assays preferred. NIH grant. Apply Personnel Director, Albert Einstein Medical Center, York and Tabor Roads, Philadelphia 41, Pa.

## POSITIONS OPEN

## IF YOU ARE AT HOME ...

with the terminology of precise sciences-

physics ... mathematics chemistry . . . electronics astronomy . . . geodesy

An intriguing and unusual job dealing with current Soviet technical and scientific literature is awaiting several men or women of suitable background and training. Qualified people will find the work rewarding, even though it will call for meeting of exacting schedules. \$7000 to \$7500 minimum.

Send resume to: Box 112, Science, 1515 Massachusetts Ave., NW, Washington 5, D. C.

Biochemist, Ph.D. or M.D., for chief of the biochemistry division of the department of pathology at a large midwestern university and teaching hospital. Excellent opportunity for independent research. Salary over \$10,000 depending upon qualifications. Position available September-October, 1959. Curriculum vitae requested. Interview arranged. Box 97, SCIENCE.

5/15, 22

#### EXPERIENCED BIOCHEMIST-MICROBIOLOGIST

Ph.D., minimum 2 years' experience in industrial fermentation research. Well-trained and versatile senior scientist. Position involves the culture of microorganisms, shaker-flask and stirred fermentor studies, isolation of biosynthetic products. Industrial pharmaceutical laboratory, New York State. Box 111, SCIENCE.

(a) Parasitologist; research department, group of well-qualified internists; should be qualified to handle tests for both clinical research purposes; vicinity Chicago. (b) Young Ph.D. in one of biological sciences interested in research purposes present of the property of the paramacology; excellent opportunity for one who prefers small research organization; typical fields in which individual might be asked to work are pharmacology of new anticholinesterases, immunological problems connected with treatment of allergies and action of certain drugs on the skin; East. (c) Clinical Chemist, Ph.D.; preferably with minimum 5 years' recent experience as chemistry aupervisor in hospital; 12-man group expanding facilities; Pacific Coast. (d) Director of Research and Development qualified to assume responsibility of research program so that present projects may be completed most efficiently and the best choice be made on development of new products; large city, Midwest. S5-3 Medical Bureau, Burneice Larson, Director, 900 North Michigan Avenue, Chicago.

## PHARMACOLOGIST

Position now available in our laboratories for Ph.D.-level scientist with 3 to 5 years' recent experience in cardiovascular research. In confi-dence kindly send curriculum vitae to Personnel

Schering Corporation

Manufacturer of Fine Pharmaceuticals
60 Orange St., Bloomfield, N.J.

SCIENCE TEACHERS, LIBRARIANS, AD-MINISTRATORS urgently needed for posi-tions in many states and foreign lands. Monthly non-fee placement journal since 1952 gives com-plete job data, salaries. Members' qualifications and vacancies listed free. 1 issue, \$1.00. Yearly (12 issues) membership, \$5.00 CRUSADE, SCI., Box 99, Station G, Brooklyn 22, N.Y. ew

## POSITIONS OPEN

Research Associate or Graduate Student to assist university Russian language biomedical literature study, New York area. Part- or full-time. Box 90, SCIENCE. 4/24; 5/1, 8

Teaching Opportunities at the College of Agriculture, University of Baghdad, in animal husbandry, irrigation and drainage, forestry, soils, agricultural extension, entomology, field crops, physics, horticulture, food technology, agricultural machinery, and dairy.

Those who are interested and have high qualifications in the subjects listed may apply to Dr. A. K. Khudairi, Dean, College of Agriculture, University of Baghdad, Abu Ghraib, Republic of Iraq.

## UNIVERSITY COLLEGE OF PIUS XII

Applications are invited for the various posts as lecturer shown below. The College is in special relationship with the University of South Africa, and is vigorously expanding. The posts would be particularly suitable for those interested in university teaching in Africa and to small classes.

Further particulars, including salary, are obtainable from the Registrar, University College of Pius XII, Roma, Basutoland, to whom immediate enquiry or provisional application should be made, mentioning qualifications, experience, two referees, age, marital status, and other relevant details. All appointments are immediate for the academic year March 1960, except as noted below. Preference will be given to applicants with experience in lecturing at a college or university.

Lecturer in Chemistry to commence work in July 1959, or as soon as possible thereafter, with at least a master's degree, preferably with special qualifications in organic chemistry.

Lecturer in Mathematics with at least M.Sc.

Lecturer in Zoology with at least Ph.D. and specialization in ecology and/or physiology, and to begin lectures in July 1959.

Lecturer in Geography with at least B.Sc.

Lecturer in Commerce with at least honors; preferably master's degree. 5/22

UNIVERSITY OF ALBERTA HOSPITAL, EDMONTON, ALBERTA, CANADA. Applications are invited for the position of Assistant Director of the Department of Clinical Laboratory Services. The duties will be concerned with the future development of the biometric of the biometric of the property of th cannot with the future development of the biochemistry laboratory service in the hospital, consulting and advising on clinical problems and research projects involving biochemistry and teaching. A teaching appointment in the University of Alberta Medical School, while not automatic with this appointment, is customary. There will be ample opportunity to carry on individual research. The qualifications required are a degree in medicine and special training and experience in biochemistry. Preference will be given to those holding the M.R.C.P. or F.R.C.P. or a doctorate degree in biochemistry. Male age 30 to 40 preferred, Salary \$10,000-\$12,000. Interested parties should apply to the Medical Superintendent, University of Alberta Hospital, giving full details and names of two references.

Zoologist. Ph.D. interested in teaching and research. Must have a good background in anatomy. Duquesne University, Pittsburgh 19, Penn.

## MAMMARY TUMORS IN MICE **AAAS Publication No. 22**

By members of the staff of the National Cancer Institute, National Institutes of Health, U.S. Public Health Service

Edited by FOREST RAY MOULTON 71/8" x 111/2", double column, cloth, references, 20 tables, 52 illus. Published 1945—Now offered at reduced

\$3.00 prepaid orders by AAAS Members, \$3.50 retail

AAAS 1515 Massachusetts Avenue, NW Washington 5, D.C.

BOOKS . SERVICES . SUPPLIES . EQUIPMENT

DISPLAY: Monthly invoices will be sent on a charge account basis—provided that satisfactory credit is established.

Single insertion
4 times in 1 year
7 times in 1 year
13 times in 1 year
26 times in 1 year
52 times in 1 year \$33.00 per inch 30.00 per inch 28.00 per inch 27.00 per inch 26.00 per inch 25.00 per inch

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

### BOOKS AND MAGAZINES



## DVORINE

PSELIDO. ISOCHROMATIC PLATES'

- Distinguishes the color-blind from the color-
- Classifies the color-blind according to type and severity of defect.
- Special arrangem prevents malingering. \$15 a set, less 5% if

accepted test in the US. Used by Medical Examin-ers of the CAA, VA and Armed you send check

SCIENTIFIC PUBLISHING CO. 2328 Eutaw Place-Dept. 5-Baltimore 17, Md.

WANTED: "The Rat in Lab. Investigation," by J. Q. Griffith, Jr., and E. J. Farris. Write H. Geiringer, 42-02 Layton St., Elmhurst 73,

## SUPPLIES AND EQUIPMENT

I.C.R DESCENDANTS

GREEN HILLS FARM Box 381, Jeffersonville, New York Tel.: 363

albino From the hand

rats\* of the veterinarian to research.

HYPOPHYSECT DAIZED RATS

- \* CHARLES RIVER C D (Caesarean-derived)
- \* CHARLES RIVER S D (Sprague-Dawley descendants)
- \* CHARLES RIVER W (Wister descendants) THE CHARLES RIVER BREEDING LABS Dept. B 1093 Beacon St.

### HYPOPHYSECTOMIZED RATS

Shipped to all points via Air Express For further information write HORMONE ASSAY LABORATORIES, Inc. 8159 South Spaulding Ave., Chicago 29, III.

#### PRIMATES

SMALL LABORATORY MAMMALS "For The Discriminate Investigator" A Complete Animal Service

RESEARCH ANIMALS, INC. 3401 FIFTH AVENUE PITTSBURGH 13, PA. PHONE: MUSEUM 1-4156

3rd printing March 1959

# ARID LANDS

A symposium volume of the American Association for the Advancement of Science

Edited by Gilbert F. White Department of Geography. University of Chicago

6 x 9 inches, 464 pages, 49 illus-trations, index, clothbound, October 1956

Price \$6.75. AAAS Members' prepaid order price \$5.75

The volume presents the efforts of scientists from 17 countries and from as many disciplines to assess the state of man's struggle to make productive and stable use of the world's arid lands.

It contains the papers and recommendations of the International Arid Lands Symposium and Conference, Albuquerque and Socorro, New Mexico, April and May 1955.

FOR EF

Box-ty

Tissue

· Assay

· Micro

INST

Strepto istics

The symposium develops around a few basic questions. The representation and treatment of the subjects are highly interdisciplinary and lead to some important conclusions. The breadth and scope are indicated by the groupings of the Conference recommendations: Anthropology, Archaeology and Geography; Meteorology and Climatology; Hydrology, Geology and Soils; Biology, Ecology and Conservation; Organization, Communication, and Interdisciplinary Programs. Workers in all these fields, as well as administrators of government and private programs, will find the contents of this volume both stimulating for ideas and invaluable as a source of information.

"An extremely useful and stimulating assessment of the subject."

British Agents—Bailey Bros. & Swinfen, Ltd., Hyde House, West Central Street, London

## AAAS

1515 Massachusetts Ave., N.W., Washington 5, D.C.



Falcon products will be exhibited . . . May 11-14 — Society of American Bacteriologists — St. Louis, Mo.

June 14-17 — American Society of Medical Technologists — Phoenix, Arizona

FOR EFFICIENT BIOLOGICAL PROCEDURES

Round and square Petri dishes

- Bi plate . . . grid plate . . . and radial counting plate

1of cne

nd

r-

0-

u-

w

ps

18.

ly

to

18.

n-

of

al-

l-

l-

y,

nd

18.

28

18,

is

or

ce

nd

- Box-type culture dishes Tissue culture plates
- + Assay spyders
- · Culture tubes and swubes
- · Microdiffusion dishes
- · Phage typing grids
- · Liquid-Tite and other disposable fluid containers.

lers convenient to you carry Falcon Products lable for immediate delivery. Ask for prices

INSTANTLY IDENTIFIED



Streptococcus...its distinctive characteristics are INSTANTLY IDENTIFIED



Palcon Disposable Plastic Petri Dishes are also INSTANTLY IDENTIFIED for added efficiency and added economy.

## Falcon Disposable Plastic Tubes

"SEALED IN" sterility from origin to instant of use

Falcon clear styrene disposable tubes are now available in a modern, sterile, strip pack. This convenient package insures unit sterility of both tube and cap...ready to use without costly, time-consuming autoclaving

For quick use...tubes are removed by tearing the paper backing across either end of the tube.

For surgical sterility...tubes are removed by peeling cellophane from the face of the pack.

Falcon low cost, one-use tubes and caps are chemically clean...biologically inert...and free of trace substances that may leach out to affect

They are ideal for blood samples, antibiotic titrations, agar slants, broth tubes, blood clot retractions and centrifuging at moderate speeds. Withstands prolonged heating at over 80°C with high resistance to both breakage and distortion.

The polyethylene caps feature two positions...a controlled loose fit for aerobic culturing and a tight seal to prevent spillage and evaporation.

Packaged STERILE...delivered STERILE...these Falcon disposable plastic tubes are available in this new, ready-to-use package at the same low cost.

NUMBER AND DESCRIPTION OF TUBES IN NEW PACKAGE:

T17100C, 17mm x 100mm, Clear, Tube and Cap T17100CNC, 17mm x 100mm, Clear, Tube (no cap)
T17100HTP, 17mm x 100mm, Hi Temp Poly, Tube (no cap)

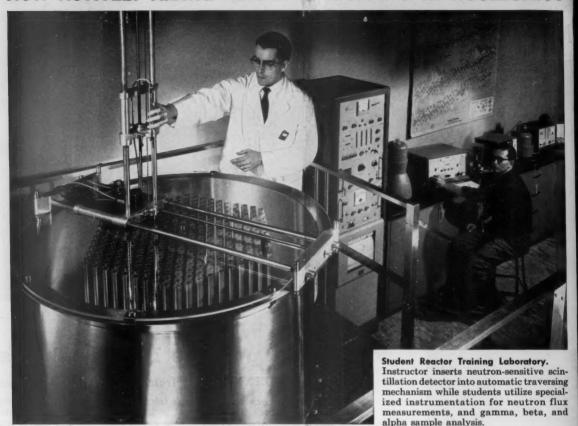
T1275C, 12mm x 75mm, Clear, Tube and Cap T1275CNC, 12mm x 75mm, Clear, Tube (no cap) T1275HTP, 12mm x 75mm, Hi Temp Poly, Tube (no cap)



6016 West Washington Boulevard, Culver City, California A Division of Becton, Dickinson and Company

FIRST AND FOREMOST IN DISPOSABLE PLASTIC LABORATORY EQUIPMENT

## NOW ACTIVELY AIDING ACADEMIC TRAINING IN NUCLEONICS



## • first nuclear-chicago reactor training laboratories now delivered to colleges and universities

• Deliveries have been completed to these institutions:

California Institute of Technology

**University of Connecticut** State University of Iowa University of Nevada **Occidental College University of Rochester Texas Technological College** 

**Utah State University** 

Nuclear-Chicago's Sub-critical Reactor Laboratory, first announced in your institution ask us to send our representative to explain it in detail.

January 1958, has been installed at eight leading U.S. Colleges and Universities. Designed for student training, the complete laboratory consists of the new Model 9000 Student Sub-critical Reactor, a carefully selected group of radiation detection and recording instruments, and a manual of experiments specially prepared for the Student Reactor and related nuclear counting systems. Instrumentation and experiments are designed to familiarize students with basic nuclear detecting and measuring devices and analytical methods, and to provide valuable reactor training in determinations of neutron flux, Fermi Age in water, relaxation lengths, multiplication factors, neutron activation, and other reactor properties. If you have not yet considered this unique package training program for

Fine Instruments - Research Quality Radiochemicals



